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THE NATIONAL ACADEMY OF SCIENCES¹

PRESENTATION OF THE COMSTOCK PRIZE

As Dr. Millikan, chairman of the Committee of Award of the Comstock Prize, is unable to be present, it has become my pleasant privilege to tell you the grounds on which the committee recommended to the academy that the prize be awarded to Dr. Ernest Orlando Lawrence.

Prior to 1919, we had no definite information concerning the interior of the nucleus of the atom. We knew that it had a positive charge equal to the sum of those of its extra-nuclear electrons. In addition to this, it was clear that the nuclei of the various chemical elements were all constructed from the same building blocks. But nothing was known about the nature of these blocks nor of the forces holding them together. The constitution of the nucleus was, then, one of the most fundamental problems that had ever presented itself to physical science.

It was Lord Rutherford who opened the door to this rich storehouse of scientific knowledge. By shooting

alpha particles into nitrogen he was able to disintegrate the nitrogen nucleus with the formation of protons and an oxygen isotope. His classical experiment was followed by the bombardment of other elements with natural alpha particles and, in this way, the nuclei of nearly all the lighter elements up to calcium were transformed. With one exception, however, all attempts to transform the nuclei of the heavier elements had failed. Thus arose the urge to produce, artificially, particles having a higher energy content than those projected spontaneously from the radioactive elements. It was clear that, given sufficiently high voltages, such particles could be produced, provided suitable tubes could be developed to withstand these difficulties and seemingly serious limitations.

Dr. Lawrence envisioned a radically different course—one which did not have those difficulties attendant upon the use of potential differences of millions of volts. At the start, however, it presented other difficulties and many uncertainties, and it is interesting to speculate on whether an older man, having had the same vision, would have ever attained its actual em-

¹ Meeting at Rochester, N. Y., October 25, 26 and 27, 1937.

bodiment and successful conclusion. It called for boldness and faith and persistence to a degree rarely matched.

In the magnetic resonance accelerator, or cyclotron, which Dr. Lawrence has created and developed, positively charged particles are accelerated so many times, as they circle about in a strong magnetic field, that they acquire energies of millions of electron volts, even though the actual accelerating potential difference is only a few tens of thousands. Not only this, but the limit to the particle energies which can be generated in this way is not yet in sight.

Many serious difficulties have arisen and been successfully overcome. There has been, for example, the very vital problem of protecting human beings in the neighborhood from the extremely penetrating and dangerous radiations produced by the cyclotron discharge. Without much intelligent care many workers might well have been seriously injured. The value of the new tool is attested by its world-wide adoption and by the variety of scientific uses to which it is being put.

Dr. Lawrence has not only created and developed the cyclotron, but, in addition to this, he has been in the forefront of those actually using high energy particles in the assault on the nucleus. With high energy deuterons he has bombarded various elements, nearly all of which have been disintegrated by these particles, in most cases giving rise to new radioactive isotopes. These new artificial radioactive elements, which will soon be available in large quantities, can be used to investigate not only other nuclear phenomena, but also the mechanism of chemical and biological processes. They may also find important therapeutic uses.

By the bombardment of beryllium with deuterons Dr. Lawrence has been able to produce neutrons at a rate which is enormous compared with the output which had previously been obtained, thus greatly extending the possibilities of their use in both nuclear and biological research.

He has accelerated doubly charged helium ions to energies greater than those available from natural alpha particle sources and with intensities thousands of times greater. The results indicate that the field of alpha particle disintegration can be expanded indefinitely with such artificial sources.

We must credit him not only with his own brilliant work in nuclear research but also with the inspiration and assistance which he has given to collaborating physicists, chemists, biologists and radiologists.

In making its recommendation to the academy, the committee has found itself in the favorable position of being able to do so on the basis of only a fraction of Dr. Lawrence's important pioneering work. I am referring by inference to such of his work as that with Dr. Sloan, in creating and developing a combination

high voltage generator and x-ray source, in which a million volts or more is generated and used inside of an evacuated grounded metal tank.

While consideration was given to the names of other men who are doing work of a high order of merit, Dr. Lawrence's work was so outstanding as to make him unmistakably the committee's choice. It then became a pleasure to make the recommendation, which we know will meet with favor both from Dr. Lawrence's colleagues and from the scientific world generally.

In closing, may I express for the committee the hope that with his youth, enthusiasm and joy in scientific work, and stimulated by the richly earned recognition which his work has received, he may continue for many years his epoch-making investigations in physical science.

WILLIAM D. COOLIDGE

GENERAL ELECTRIC COMPANY,
SCHENECTADY, N. Y.

RESPONSE BY PROFESSOR ERNEST O. LAWRENCE

WORDS fail me in expressing my deep appreciation of this great honor. You all know from your own experience that scientific advances are rooted in the past and always involve, directly or indirectly, the work of many contemporaries—that no individual is alone responsible for a single stepping stone along the path of progress. In my own endeavors this has been particularly true, for from the beginning it has been my good fortune to be associated with men of outstanding ability and devotion to science, a circumstance which has indeed been as much a source of joy as the satisfaction of contributing a little to scientific progress.

In 1930, three splendid students embarked with me on the voyage of experimental research that has reached the destination you have seen fit to recognize so magnificently this evening. In the spring of that year, Niels Edlefsen built the first model of the apparatus which has come to be known as the cyclotron, and although it was very crude, the indications of its performance were encouraging. Perhaps some of you will remember that we presented a paper on these first experiments before the meeting of the Academy in Berkeley. In the fall, Stanley Livingston carried forward with unusual ability and enthusiasm the experimental development begun so well by Edlefsen. Livingston being an untiring worker, it was not long before a model of the cyclotron was evolved, which worked well enough to assume a significant place in nuclear research. He had a prominent part in our work for two years more and all of us in the laboratory greatly regretted his leaving, for he contributed so much to our joint endeavors. A third student of those early days was David Sloan, an experimenter of rare genius. Although he was not primarily concerned

with the cyclotron, he did, in fact, contribute a great deal to its development and to the general technique of the laboratory. Following these young pioneers, our laboratory has been blessed with a succession of fine men, and I wish there were time here to pay proper tribute to them all. May I at least acknowledge my appreciation of a great friend and valued scientific colleague, Donald Cooksey, who during the past three years has played an important part in the work of the laboratory and especially has been largely responsible for the improvement of the cyclotron. In thanking you for this greatly appreciated honor, I do so with the happy thought that I am the representative of these valued associates and intimate friends.

Perhaps I may be permitted to add a few remarks in the nature of a prognosis, for it seems clear that we are now on the threshold of a new scientific epoch, having much the same character as that which followed the discovery of x-rays and radioactivity. I need not recall the development of modern atomic physics and the benefits to the medical sciences that came from these discoveries. The recent discoveries in the domain of the atomic nucleus—notably neutron rays and artificial radioactivity—have similarly opened up new vistas of incalculable importance. Although I might more properly speak of the problems of the physical sciences that have come to view, with your permission I should like to call particular attention to the bearing of these recent advances in nuclear physics on problems of the biological and medical sciences; for there are grounds for the view that the fundamental problems of biology are at the moment of greater importance than those of physics.

From the moment of discovery it was apparent that neutron rays might have important applications in medical science, for although they are similar to x-rays in their penetrating power, the mechanism of their absorption in matter is quite different. Recent experiments indicate that neutron rays do indeed produce quite different biological effects from those produced by x-rays, shedding fundamental light on certain biological processes induced by ionization and giving strong hopes that for certain therapeutical purposes the neutron ray may be extremely valuable.

The discovery that it is possible to produce radioactive forms of the common elements is also of tremendous importance for biology. These artificial radioactive substances, which apart from their radioactivity are chemically and biologically indistinguishable from the ordinary elements, conveniently manifest their presence by the powerful radiations they emit. They are tagged atoms which are easily traced through a complicated biological system. During a visit in our laboratory last year, Professor A. V. Hill, the distinguished physiologist, emphasized his view of the importance of the artificial radioactive substances

as tracer elements in biological research by predicting that future history will rank this technique of equal importance with that of the microscope. It will be said that the microscope revealed the cells while the artificial radioactive substances permitted the biologist in effect to see the atoms themselves. It seems clear that the biologist has at hand a powerful new technique and that we may look forward to significant advances in this field which otherwise would have been impossible.

It is a tremendous source of satisfaction that valuable contributions to biology and practical medicine are emerging from researches on the fundamental problems of atoms. Although the history of science records a convincing story of the great practical benefits that always accrue to humanity from fundamental research, nevertheless those of us engaged in pure science can not help but entertain occasional thoughts that possibly our efforts in solving some puzzling scientific problems may not be of greater significance than a fascinating game of chess. In this distinguished gathering it is not necessary to point out the essential unity of science or a justification for fundamental research, but may I confess that close association with these developments in nuclear physics having bearing on the medical sciences has made me appreciate more fully the fact that an advance of the horizon of knowledge in any direction uncovers territory of all the sciences.

In closing, Mr. President and members of the academy, may I reiterate my deep appreciation and thank you for myself and in behalf of my colleagues, who share with me this great honor.

ABSTRACTS OF PAPERS

The Volcano Tarawera in 1886: ARTHUR L. DAY. In any comparative study of hot-spring activity in the North Island of New Zealand and our own Yellowstone National Park one fact stands out in dominating relief. Primary volcanic activity in Yellowstone Park ended in quiet rhyolite flows in the Pliocene epoch, while at least two volcanoes in the New Zealand group are still intermittently active. Tarawera in 1886 was violently explosive, and out of the nine-mile rift which opened during this eruption there broke forth in 1902 the greatest geyser (Waimangu) of which we have a historic record. Three years later the geyser had, apparently, exhausted itself and no trace exists to-day of its point of emergence. This eruption of Tarawera and some of its consequences was described (with illustrations).

The University of Rochester-Bishop Museum Geological Expedition to Lau (Eastern Fiji): J. EDWARD HOFFMEISTER and HARRY S. LADD (introduced by T. Wayland Vaughan). In January of 1934, the writers left Rochester for several months of geological work in the Lau Islands (eastern Fiji). Twenty-six islands were studied and nine geologic maps were prepared of the most im-

portant of these. Large collections of rock specimens, fossils and water samples were made which have since been studied by various specialists. Twelve separate studies are now ready for publication. Available data support the following conclusions: Igneous rocks of three periods of volcanism occur in the islands. Rocks of the first period are chiefly andesites and occur widely throughout Lau. Those of the second period are chiefly olivine basalts and have a somewhat more restricted distribution. Odinites, representing the third period of volcanism, occur in a few places. Agglomerate is the commonest rock type, but tuffs, flows and dikes are present in many places. It appears that there have been two main periods of limestone deposition. The older and more wide-spread of these was deposited during the interval between the first two periods of volcanism and can be correlated with the upper part of the "Lower Miocene" of the East Indian section (Stage "f" of the Van der Vlerk-Umbgrove classification). The younger of the two limestones was laid down following the second period of volcanism, and contains a greatly different fauna from that of the older. Some of the Lau Islands have been described as elevated atolls. Our studies indicate, however, that the basin shapes of these atoll-like islands are due to atmospheric solution and marine erosion acting on elevated submarine banks. The petrographic study of the limestones has given a considerable amount of information about their origin and extent of alteration.

Methods of inducing chromosome doubling in plants by treatment with colchicine: A. F. BLAKESLEE and A. G. AVERY. A number of chemicals have been tested with *Datura* and other plants in an effort to induce hereditary mutations. Narcotics had previously been found effective in inducing doubling of chromosomes in roots, but chloral hydrate and nicotine were found ineffective in inducing chromosome doubling in stems which alone bear seeds and thus might lead to production of $4n$ races. The alkaloid colchicine we have found will induce an abundant production of branches with doubled chromosome number. When seeds are heavily treated, all the seedlings may be affected. The stem becomes swollen while the growth of root and plumule is checked; buds are abnormally arranged leading to sectors with roughened leaves characteristic of mixed $4n$ and $2n$ tissue like spontaneous $4n$ sectorial mutations. Normal $2n$ tissue tends to outgrow the mutated $4n$ tissue, but the latter may include the whole shoot. Between one half and one third of plants from treated seeds have produced $4n$ flowers. Apparently sectors of $8n$ tissue have been secured by treating $4n$ plants as well as by heavy treatments of $2n$ individuals. Tetraploid tissue involving the flower may readily be determined by examination of pollen. In *Datura* and *Portulaca* the determination by pollen size has been checked by chromosome counts. Doubling in adult tissue has been induced by immersion of twigs in solutions and in agar, by treatment of buds with mixtures of colchicine and lanolin and by spraying with solutions. By use of colchicine changes have been induced which are interpreted as due to doubling of chromosomes in the following genera: *Datura* (several species), *Portulaca* (2 species),

Cosmos (2 species), *Phlox*, *Stellaria*, *Nicotiana*, *Digitalis*, *Mirabilis*, *Tropaeolum*, *Cheiranthus*, *Raphanus*, *Cucurbita*, *Trifolium*, *Medicago* and *Allium*. If control of chromosome doubling by chemical means proves of general application, as seems to be the case, the plant breeder will be able to work with greater precision in his efforts to control the evolution of economic forms both of plants propagated vegetatively and of those reproduced by seed. For example, it should be possible, starting with a sterile hybrid, to synthesize a pure-breeding double diploid which would have hybrid vigor and the desirable characteristics brought about by tetraploidy. This we have apparently succeeded in doing with a species hybrid in *Nicotiana*. Doubling chromosome number would give enlarged flowers and fruits to the horticulturist and through triploids would be the basis of a wide range of $2n+1$ types. Tetraploidy and presence of unbalanced extra chromosomes are known to have been factors in the origin of a large proportion of our most desirable varieties of fruits and flowers. In addition to increase in size of organs of the plant, tetraploidy has changed a self-sterile to a self-fertile form, a dioecious to a hermaphroditic race, an annual to a perennial, and has increased winter hardiness. The ability to induce chromosome doubling, therefore, is of importance to practical as well as to theoretical genetics.

The determination of color in the vasa efferentia of Drosophila melanogaster: CURT STERN and ERNST HADORN (introduced by C. B. Davenport). Males of *Drosophila melanogaster* which possess pigmented eyes (wild, carnation) contain yellow colored testes and vasa efferentia. In males with unpigmented eyes (white) the testes and vasa are colorless. Gonads and ducts originate independently and only later in development become attached to each other. By means of transplantation of testes from genetically "colored" into "uncolored" larvae and *vice versa*, a dependence of the pigmentation of the host ducts on the implanted gonad was demonstrated. No influence on the coloration of the vasa is observed when the implant does not become attached to a duct except in a few cases, in which vasa of uncolored constitution possess small colored spots. However, when the implant connects with a vas, either by itself or after having formed a compound gonad with a host testis, the ducts may show a pigment condition which does not correspond to their genetic constitution. Ducts of "colored" genotype may remain completely or partially colorless when attached to unpigmented testes, and ducts of "colorless" genotype may form pigment over all or part of their surface. In the latter case often both vasa are pigmented though only one is attached to a colored gonad. Whether the pigmentation of the ducts is induced by contact with genetically "colored" testis tissue or whether it is due to overgrowth of pigmented cells from the testis is undecided.

Rat embryo development in circulating fluids: J. S. NICHOLAS (introduced by Ross G. Harrison). The embryonic tissues of the rat possess the capacity of growing and differentiating under various experimental conditions. This has been tested by transplantations either

within the uterus or to sites other than the uterus in which the fate of the developing tissues can be followed, and also by a series of explanations involving an entirely different environment in which the embryo develops. The results of the transplantations showed that the tissues either separately or in combination were capable of a greater degree of differentiation than that obtained by the conventional tissue culture methods. The explanations showed that some factor limiting growth and differentiation was present in the conventional type of tissue culture since conditions were inadequate to maintain normal growth rate and to regulate developmental form. In order to secure material for analysis, a type of tissue culture employing a circulating system was devised and the following results obtained. Growth and development occur more regularly and more like the normal processes in circulating cultures than in the conventional type; embryos develop in fluids either from their own species or those from widely separated groups; they are not injured by gradual changes in temperature between 70° and 110° F.; they can adapt to variations in hydrogen ion concentration and also to changes in pressure over a comparatively wide range. The present method has permitted continuous observations during the critical ninety-six hours of development during which the definitive embryo is formed.

Interpretation of certain infantile growth curves: C. B. DAVENPORT. To test the application of the autocatalytic monomolecular reaction theory of Robertson to the growth of the arms of infants, the proximal and distal segments of various babies' arms were measured from birth to 12 months. During this period the humerus continues a rather uniform growth, whereas the radius nearly ceases to grow, toward the end of the first year. The brachial index ($\text{radius} \times 100 \div \text{humerus}$) changes from, on the average, 90 at birth to 78 in the adult. The reduction in growth of the radius is ascribed to an inhibitory factor furnished by a human gene which keeps the fore-arm from the excessive length attained in anthropoid apes, especially the gibbon and which is in them adapted to arboreal life. The growth of each individual part in man is controlled by laws of its own, the end result of which is a greater fitness to environment of the organism as a whole.

Stimulus intensity as a determiner of the characteristics of behavior in the fetal guinea pig: LEONARD CARMICHAEL (introduced by Walter R. Miles). This paper reports an experimental study of the effect of the intensity of stimulation upon the character of behavior released in a typical fetal mammal at characteristic stages in motile prenatal life. The first set of experiments was conducted upon a series of fetuses by the use of stimuli of known temperature above or below the physiological zero of the organism. The second set of experiments was conducted by the use of pressure stimuli produced by calibrated von Frey esthesiometers. The technique of both experiments is briefly described and quantitative results are given which support the conclusion that the intensity of the stimulus itself is an important factor in determining the character of fetal behavior released by stimulation. In

general, at all fetal stages studied and in all typical reflexogenous zones, the more intense stimuli released larger and more generalized patterns of response than did the less intense stimuli. The bearing of these results upon such questions as the problem of the origin of reflexes is pointed out.

The action of synthetic male hormones upon the differentiation of sex in the chick embryo: B. H. WILLIER (introduced by Frank R. Lillie). Solutions (propylene, glycol, sesame oil) of the synthetic male hormones, androsterone, dehydroandrosterone and testosterone propionate, in dosages from 0.02 mg-2.0 mgs, were introduced into eggs incubated from 48 to 72 hours. Development was continued until the sixteenth to eighteenth days. By using embryos with a sex-linked plumage character the original sex was readily ascertained. In the genetic females these substances modify the form and structure of the gonads and gonoducts. The right ovary hypertrophies into a cylindrical testis-like body consisting of medullary tissue and testicular cords in various stages of formation. The left ovary likewise assumes a testis-like form. With low dosages of the hormone its medulla hypertrophies; with higher dosages (0.75 to 2.0 mgs) the cortex degenerates more or less and testicular cords appear in the medulla. The testicular cords appear only at the hilus and beneath the degenerating cortex. Those in the latter position are sterile. The two oviducts respond quite differently: the left becomes rudimentary, the right abnormally long. The Wolffian ducts and certain mesonephric tubules which begin to hypertrophy with low dosages, become enormous when 1 mg or more is given. In the genetic males the gonads and gonoducts react differently to the various hormones used. With testosterone propionate the testes are reduced in size but remain essentially normal in form and structure. Oviducts never persist. Androsterone and dehydroandrosterone, however, produce a strong feminizing action similar to that of oestrone and oestriol (Willier *et al.* '37), i.e., the left testis becomes a flattened ovary-like body consisting of both ovarian and testicular tissues (ovotestis), while the right retains its testicular character. Both oviducts persist and may hypertrophy. The Wolffian ducts and certain mesonephric tubules hypertrophy as they do in the genetic females. The results clearly show that androsterone and dehydroandrosterone have both masculinizing and feminizing effects on the differentiation of the sex glands and ducts, while testosterone propionate has a masculinizing effect only.

Failure of progesterone to prevent resorption of embryos in rabbits castrated in very early pregnancy: WILLARD M. ALLEN and GEORGE P. HECKEL (introduced by Carl G. Hartman). Crude progesterone-containing extracts of the corpus luteum are capable of maintaining pregnancy to term in rabbits castrated eighteen hours after mating (Allen and Corner, 1930). Data from experiments by them show that in each case (10 animals) in which the daily dose was 0.4 rb.u. or more, normal embryos were present on the eleventh day. When the quantity was less, embryos were not always present. In direct contrast to these results with crude extracts, we have found purified, oestrin-free, progesterone-containing

corpus luteum extracts and progesterone itself practically incapable of maintaining pregnancy. Twelve animals, each castrated the day after mating, were given from 0.4 to 1.5 rb.u. of hormone daily and an exploratory laparotomy done on the eleventh day. In eight animals no embryos were present. In one animal there were several resorbing implantations. In the other three there were normal embryos, but only one of these was successfully carried to term, the other two resorbing their fetuses prior to the twenty-first day. The only hormone, in addition to progesterone, known to be present in the crude extracts and not in the highly purified extracts or in progesterone is oestrin. Consequently we have given both oestrin (progynon-B) and progesterone to a small group consisting of six animals and have obtained normal embryos on the eleventh day from five of them.

Azacyanines: L. G. S. BROOKER and R. H. SPRAGUE (introduced by G. H. Whipple). In most cases the appearance of color in organic compounds is dependent on the presence in the molecule of long chains of atoms which are linked together by alternate double and single bonds, so-called conjugated chains. In the polymethine dyes the chains are of the type $=CH-CH=CH-CH=CH-$, etc., and previous workers have found that replacement of a $-CH=$ group in certain polymethines by N usually either makes but little difference to the color or else deepens it. The thiocarboecyanine dyes contain the trimethine chain $=CH-CH=CH-$, and we have found that if the central $-CH=$ group of a red dye of this class is replaced by N the color is deepened to bluish-red, in accordance with the above rule. But on the other hand, if a terminal $-CH=$ group is replaced by N the color is lightened to yellow. A theory is offered which explains this apparent anomaly and which furthermore is in agreement with the observed colors of dyes containing the chains $=N-CH=N-$ and $=N-N=CH-$. The dye containing the chain $=N-N=N-$ has also been made, but its color is anomalous unless a further assumption is made, when it, too, falls into line.

General transformations and optics: EDWARD KASNER. A double infinity of curves in space for which orthogonal surfaces can be constructed is called a *normal congruence*. If such congruence is reflected or refracted in any isotropic medium it remains a normal congruence, and therefore the concept is important in geometric optics. The author finds all transformations of lineal elements which convert the normal type into itself. The infinite group obtained is isomorphic with the contact group of surface elements. The only transformations of the new group which convert curves into curves are those of the conformal group. It is shown that if the involution type of pair of partial differential equations is invariant we obtain the contact group. An equivalent problem is connected with integrable Monge equations. Finally the general theory of transformations converting line elements into surface elements is developed. This leads to very extensive new classes of transformations. Elements of higher order are studied.

Measurement of solar radiation from high altitude

sounding balloons: B. O'BRIEN, L. T. STEADMAN and H. S. STEWART, JR. (introduced by Charles G. Abbot).

The photographic emulsion as a tool in nuclear research: T. R. WILKINS (introduced by A. H. Compton). Fine-grained photographic emulsions have been used for a number of years to record the tracks of alpha rays. Some, but not all, of these emulsions have been found to respond to protons as well. If the grains are too small the emulsion may still be sensitive to alpha rays but have become insensitive to protons. For intermediate sized grains, the emulsion responds both to protons and alpha rays. For slightly larger grains a differential response is secured—the grain-spacing in the grains of a track varying not only for the different particles but varying along the track of any given particle. A properly chosen photographic emulsion thus provides a remarkable tool for identifying nuclear atomic particles and also of estimating the energies of the particles both from total track length and from the grain-spacing. Standardization curves for certain emulsions will be given for alpha rays, deuterons and protons and some examples of the application of the techniques in studying disintegrations produced by cosmic rays and also by radioactive radiations.

Double ionization of atoms: F. K. RICHTMYER and R. E. SHRADER. The origin of x-ray satellites—faint spectral lines appearing on the short wave-length side of the more prominent lines—long remained a puzzle until Coster and Kronig (*Physica*, 2: 13, 1935) suggested that the doubly ionized state requisite for the production of these lines could be produced by a kind of internal photoelectric absorption of energy—the so-called Auger effect. Tests in this laboratory and elsewhere have tended to confirm this suggestion as a working hypothesis to explain the relatively high intensity of these lines in certain atomic number ranges. According to the Coster-Kronig theory, the satellites of the x-ray line L_{α} ($L_{III} \rightarrow M_{IV, V}$) should be strong in the atomic number range $40 < Z < 52$ (about); should be very weak or absent in the range $52 < Z < 72$; and should reappear above Hf72 (about) and increase in intensity for higher atomic numbers. These predictions are in qualitative agreement with data from spectrum plates. We have made measurements of the line L_{α} and its accompanying satellites for nine elements in the range Ta73 to Th90, by means of a two-crystal ionization spectrometer of high resolving power and precision. Making the somewhat arbitrary assumption that L_{α} is symmetrical about its point of maximum intensity, as a means of locating the background of the satellite structure, we have determined the intensities of the satellites relative to L_{α} (ratio of areas) with the following results:

*Ta73	2.1%	Pt78	5.3%
W74	3.3	Au79	6.7
Re75	4.4	Pb82	6.2
Ir77	5.2	Th90	6.2
		*U92	5.4

* Preliminary data.

These data provide added quantitative support to the Coster-Kronig theory. The senior author wishes to ex-

press his thanks to the Carnegie Corporation of New York for a grant in aid of this research.

An improved cyclotron: ERNEST O. LAWRENCE and DONALD COOKSEY. This paper describes in some detail an improved and larger cyclotron, which has been in operation now for two months. Ions are accelerated to circles 30 inches in diameter within electrodes (dees) having an internal width of 3 inches. These wider dees have resulted in a much larger current output, and the larger diameter has made possible higher energies. At 4.7 million volts steady deuteron currents of 100 microamperes are obtained. At 6.8 million volts the deuteron current is about 40 microamperes, while at 7.8 million volts, the present operating voltage, the currents are between 3 and 10 microamperes. The variation of the output current with the applied high frequency voltage indicates that with increase of high frequency power input the obtainable currents above 7 million volts will be approximately equal to those obtainable at lower voltages. The yield of neutron rays from this cyclotron is as great as would be obtained from a mixture of beryllium and several hundred kilograms of radium. Moreover, artificial radioactive substances are producible in amounts equivalent in temporary radioactivity to several grams of radium. This cyclotron has many practical operating conveniences, not the least important of which is the use of rubber gaskets instead of wax, solving the problem of a leak-proof vacuum system.

Proton-induced radioactivities: L. A. DUBRIDGE and S. W. BARNES (introduced by E. O. Lawrence). A cyclotron patterned after the design of Lawrence and Livingston has been used for the investigation of nuclear reactions produced by protons of energy up to about 4 m.e.v. Previous proton work, confined to energies below about 1 m.e.v., has revealed two types of proton reactions in light elements: (1) radiative capture and (2) capture with alpha-particle emission. Further examples of these reactions for heavier elements (*e.g.*, Zn) have been found in the energy range 1-4 m.e.v. In addition a new type of reaction in which the proton expels a neutron has been found to set in at energies above about 2.5 m.e.v. This reaction leads in nearly every case to a positron emitting radioactive isotope which decays to the original bombarded isotope. The mass relations are thus quite simple and show that for any element this reaction becomes energetically possible for protons of energy equal to 1.8 m.e.v. plus the maximum energy of the positrons (usually .5 to 3 m.e.v.). The following are the isotopes and periods for which this reaction has been established: $O^{18} \rightarrow F^{18}$ (107 min); $Cr \rightarrow Mn$ (40 m); $Co^{59} \rightarrow Ni^{59}$ (? (2.5 hr); $Ni \rightarrow Cu$ (2.7 hr, 10 hr); $As^{75} \rightarrow Se^{75}$ (109 m); $Se \rightarrow Br$ (16 m, 40 m, 5 hr, 34 hr) ?. Activities in several other elements have also been found and the reactions are now being identified. A larger accelerating chamber is soon to be installed which will allow the studies to be extended up to proton energies of 6 to 7 m.e.v.

Superinfection in virus-induced tumors: JEROME T. SYVERTON and GEORGE PACKER BERRY (introduced by

Thomas M. Rivers). Papillomata induced in domestic and cottontail rabbits by Shope's papilloma virus have been easily superinfected with a number of other filterable viruses, both alone and in combination. Furthermore, the carcinomata, which in certain instances follow the papillomata in both types of rabbits, have similarly been infected with viruses. In addition to Shope's papilloma virus, the viruses employed in these studies have included herpes virus, B virus, virus III, vaccine virus and *Virus myxomatosum*. Evidence of superinfection has been derived from histopathological appearance, recovery of the virus by suitable animal passage and identification by immunological procedures. Since extraneous viruses, extraneous in that they have no etiological significance for the tumor under investigation, can be implanted with ease in virus- and in non-virus-induced tumors, it follows that the mere presence of a virus in a tumor is no proof that the virus is producing that tumor. These findings emphasize the necessity for conservatism in evaluating the rôle of a virus recovered from a tumor, for example, the rôle of papilloma virus in the carcinomata which follow papillomata.

The vascular pattern of the tumor transplant with a possible explanation of one method of metastasis: A. GORDON IDE and STAFFORD L. WARREN (introduced by G. H. Whipple). A transparent window of cellulose acetate film base is placed on the inner and outer surfaces directly upon the subcutaneous tissue in the ear of the rabbit. A fragment of Brown-Pearce rabbit epithelioma is transplanted under the outer window. The development of the characteristic pattern of capillaries growing up, around and into the growing tumor may be observed under rather high magnifications (900 times) with proper technique. The development of a large, open, sinuous vessel at the growing tumor edge has been observed twice. In addition, a motion picture record (in color) has been made of a fairly large blood vessel partially stripped of endothelium so that direct washing in and out of serum, red blood cells and apparently tumor material can occur with ease. Several pieces of tumor material appear to drift into the blood stream in this film. Because of the extremely rich, vascular network of large, thin-walled vessels and the frequency of rupture of the latter by very minor trauma, it is highly probable that tumor fragments both living and dead drift into the blood stream in far greater numbers than has been supposed.

The effect of freezing on the growth of mammalian transplantable tumors: G. BURROUGHS MIDER and JOHN J. MORTON (introduced by Harvey Cushing). It has been shown by previous investigators that primitive forms of life can withstand freezing temperatures. Interesting observations have been recorded on the freezing of bacteria and viruses. A combination of freezing and desiccation has made it possible to store bacteria and their products for long periods of time, thus saving the necessity of repeated transfers. Malignant tumors of rats and mice have been tested by others for their ability to withstand freezing temperatures. The results obtained have been conflicting. In the experiments reported here,

rat carcinomas and mouse sarcomas have been subjected to freezing temperatures, ranging from -40°C. to -60°C. Studies have been conducted with respect to the rate of freezing; the duration of time in the frozen state; the physical state of the frozen material; and the effect of repeated freezing and thawing. Mouse sarcoma cells were not damaged to any appreciable extent by rapid freezing within five minutes or prolonged freezing for 24 hours. Progressively growing grafts could be obtained from this frozen material in approximately the same proportions as from the normal tumor. Rat carcinoma cells when rapidly frozen once at -60°C. showed evidence of damage by a latent period before growth occurred in animals grafted with these cells. There was also a diminished percentage of success, as only about half as many tumors were obtained after this treatment. Freezing and thawing for four times did not alter this result. But cells dispersed in a saline medium were still more sensitive, giving only a small number of tumors. When frozen and desiccated in the lyophile apparatus the cells were rendered incapable of further producing tumors on transplantation. These experiments have been designed to establish a definite lethal point for freezing effects on tumor cells. When this has been determined, problems bearing on immunity to transplantation; on the extraction of growth stimulating and inhibiting substances; and on the possible demonstration of a filterable agent will be carried out. From the standpoint of immediate utility, it may be possible to carry laboratory animal tumors in a frozen state, thus obviating the necessity for repeatedly transplanting them to living animals.

Amino acids (natural and synthetic) as influencing hemoglobin production in anemia: GEORGE H. WHIPPLE. We wish to submit evidence that histidine, leucine and phenylalanine (both natural and synthetic forms) may under certain conditions exert a definite influence upon the regeneration of red cells and hemoglobin in standardized dogs made anemic by blood withdrawal. It has been believed by chemists and physiologists that the natural forms of the amino acids are much more active in protein metabolism than the optical isomers or the synthetic dl forms. The evidence relating to hemoglobin production (internal protein synthesis) indicates that in an emergency (anemia) the dog can use all forms of certain amino acids to increase the hemoglobin production.

Injected plasma protein utilized by phlorizinized dogs: W. B. HAWKINS (introduced by G. H. Whipple). Dogs were made diabetic by means of phlorizin and then were given dog plasma protein by mouth or intravenously. The injected protein promptly disappears from the blood stream, but there is no excess nitrogen or sugar eliminated in the urine. There is no loss of protein in the urine. When the plasma protein was fed, it was digested, and subsequently there was an excess of nitrogen and sugar, indicating amino-acids had been formed with conversion of some of them to sugar. It is evident that the metabolism of the protein, when fed, is different than when it is injected. It is suggested that there is a partial katabolism of the injected protein with the formation of large aggregates. The various body cells then reassemble

these large aggregates and form their own peculiar type of protein.

New results on the absorption of insulin from the alimentary tract: JOHN R. MURLIN, LAWRENCE E. YOUNG and WILLIAM A. PHILLIPS (introduced by E. G. Conklin). This is a study of the mechanism underlying absorption of an undigested native protein, with very obvious practical applications. The advantage of insulin over other proteins of similar molecular weight or solubility is that its effect on blood sugar level furnishes a good measure of the absorption rate. Proof of the possible absorption of insulin, when protected from destruction by pepsin of the stomach and trypsin of pancreatic juice, is now entirely conclusive. But wide individual differences remain and dosage requirements to produce therapeutic results are high. Recent studies in our laboratory demonstrate that two classes of substances put into the intestine with insulin promote its absorption: (1) Those which clean the mucosal surface of mucin; and (2) those which lower surface tension. Weak acid or alkali belong to the former class; bile salts, saponin and hexylresorcinol to the latter. The last-named substance in weak solution of the pure substance, together with weak soda solution and 100 units of insulin, in some dogs will accelerate absorption of the protein sufficiently to produce a sharp fall in blood sugar in more than 80 per cent. of the trials; in other animals not more than 50 per cent. The most favorable reaction of the mixture swallowed is at pH 9.9 to 10.5 (electrometric). The most favorable surface tension is in the neighborhood of 31 to 33 dynes per cm (stalagmometer). Heptyl- and octyl-resorcinol are no better than hexyl. There is a strong probability that the alkyl derivatives of resorcinol exert some hydrotropic effect on the solubility of proteins, thereby affecting the isoelectric point. Just how useful or practical these results will prove to be in the treatment of human diabetes remains to be seen.

Enterocrinin, an intestinal secretory hormone: E. S. NASSET (introduced by Eugene F. DuBois). Surgical transplantation of segments of small intestine to the mammary glands provided test animals with which it was possible to demonstrate the existence of a blood-borne excitant for the intestinal glands (Nasset, Pierce and Murlin, *Amer. Jour. Physiol.*, 111: 145, 1935). In a search for the humoral agent it was soon discovered that simple extraction of the small and large intestines of several species, including man, yielded a very active intestinal secretagogue for which the term *enterocrinin* is proposed. With the development of a rapid method of assay it was possible to keep pace with the chemical fractionation of the extracts so that at present enterocrinin is obtained in the form of a white, water-soluble powder active in doses of 0.2 to 0.4 mg per kilo of body weight. The early results with crude extracts were complicated by diminished blood pressure and excitation of the pancreas. The present method of preparation eliminates the substances responsible for these side effects. Since enterocrinin acts in the presence of atropine, does not depress the blood pressure nor excite the pancreas, it can not be acetylcholine, histamine or secretin. The evidence at hand warrants the conclusion that it is a new hormone, the

function of which is to stimulate the production of all components of the intestinal secretion, including the digestive enzymes.

Reversible heat activation of the enzyme carboxylase within a living cell: DAVID R. GODDARD (introduced by William Albert Setchell). A manometric method has been devised for studying the activity of the enzyme carboxylase in living cells. The method depends upon the fact that the anaerobic production of carbon dioxide is poisoned by sodium fluoride, but that the liberation of carbon dioxide by the enzymatic decarboxylation of pyruvic acid is not inhibited. This method has been applied in following the reversible activation of carboxylase in living spores. The ascospores of the fungus, *Neurospora*, are dormant. Exposure of the spores to temperatures of 50° C. or higher for a few minutes induces germination several hours after returning to room temperature. Measurements of carboxylase activity at 25° C. have shown that the dormant spores have zero activity, but that the heat treated (activated) spores have marked carboxylase activity. Under anaerobic conditions the carboxylase activity falls to zero after two or three hours at 25° C. The full carboxylase activity may be regenerated by a second heat treatment. The activation of carboxylase is therefore reversible and may be controlled at will.

Movements of potassium during muscular contractions: W. O. FENN (introduced by W. J. V. Osterhout). Further evidence is presented to show that potassium is lost from muscles during contraction, whether voluntary or resulting from electrical stimulation. The data are most complete for cats and rats, but a loss can also be demonstrated in frogs if the period of stimulation is sufficiently long (one and a half hours) and the individual contractions are not so frequent as to cause excessive fatigue. A continuous tetanus fatigues the myoneural junction and inhibits the contraction and the loss of potassium. The loss of potassium is not determined by the degree of asphyxia of the muscle, for it was greater in the soleus muscle with a low lactic acid content (100 mgm per cent.) than in the gastrocnemius muscle with a high lactic acid content (608 mgm per cent.). Moreover, cutting off of the blood supply to a stimulated muscle diminishes the loss of K more or less in proportion to the diminution in the amount of tension developed. The loss of K is not proportional to the number of nerve impulses delivered to the muscle, for it is less for a continuous tetanus than for an intermittent one. An increase of K in the blood is regularly observed during stimulation, but not over 10 per cent. of the total potassium lost can be accounted for in the blood.

On the kinetics of recovery during the refractory period in nerve: H. A. BLAIR (introduced by K. T. Compton). It appears likely that by means of stimuli of short equal durations and variable strengths one is enabled to describe the refractory period of nerve in terms of, and only in terms of, the ratios, $S = K/h$, K being the rate of accumulation of the excitatory state per unit stimulus and h

being the threshold value of the excitatory state. At the end of the absolute phase, this state, S , beginning at 0 returns to its end point, S_0 , at a rate proportional to the distance remaining. The end point, however, depends upon the rate of some oxidative process which is raised by the response and which recovers exponentially to its resting value. When its recovery is fast there is no supernormal phase of excitability, but when it is slow there is a supernormal phase as well as an evident after-potential which is associated in some way with the excess oxidation. The time constant of the recovery of the state, S , is independent of pH, and of fiber size to some extent, but is increased about three-fold with 10° C. rise in temperature. The time constant of the oxidative process varies similarly with temperature but is increased very greatly on going from acidic to alkaline media. If both of these processes are chemical, a method is provided of studying the reactions concerned with much greater accuracy than is ordinarily possible. In any case, the mode of variation of the time constants of these processes with different reagents and conditions should throw considerable light on the nature of the excitatory mechanism and of the refractory state.

The cortical representation of respiratory movements: WILBUR K. SMITH (introduced by George L. Streeter). The deduction is ordinarily drawn, from both subjective and objective data, that in man the cerebral cortex is able to influence respiratory movements. Evidence to indicate that this is not an attribute of the human cortex alone is obtained from electrical stimulation of the cerebral cortex in mammals. In the cat and dog, under light ether anesthesia, an inhibitory effect upon breathing characterized by a temporary cessation or slowing is most easily elicited from an area in the gyrus compositus anterior. A less marked but definite inhibitory effect is obtained from most of the cortex of the sylvian and ectosylvian gyri, and in the cat from the gyrus proreus as well. Increase in the depth of anesthesia results in abolition of the response, the area in the anterior composite gyrus being the last to succumb. A similar inhibitory effect is obtained in the monkey from the cortical region just caudal to the lower end of the inferior precentral sulcus. From other areas of the cortex a marked acceleration of breathing can be obtained. Recordings from the diaphragm show that the effect is bilateral. A reversal of response sometimes occurs, especially under very light anesthesia. The inhibitory and acceleratory areas are present on both sides of the brain. Undercutting the area abolishes the response, but it may then be obtained by stimulation of the cut ends of the nerve fibers. The response is not abolished by section of the corpus callosum, by removal of one hemisphere, by bilateral section of the phrenic nerves and the vago-sympathetic trunks or by section of the spinal cord below the origin of the phrenics. Changes in arterial pressure usually occur simultaneously with the respiratory alterations. Neither effect is abolished by denervation of the carotid sinuses.

(To be concluded)

SCIENTIFIC EVENTS

SYMPOSIA ORGANIZED BY THE SECTION
ON MEDICAL SCIENCES (N) OF THE
AMERICAN ASSOCIATION FOR
THE ADVANCEMENT OF
SCIENCE

THE development of the programs of symposia by Section N (Medical Sciences) of the American Association for the Advancement of Science began in June, 1934. In the beginning very modest programs were planned. It was felt best to gradually develop the idea of specializing our programs in certain fields of medicine until eventually the symposium would become the major part of each meeting.

Under the former system of building programs, the secretary of the section received requests from various members to present papers, and also from persons not members of the association. The subjects presented were of such a wide variety that no single person could pass upon their merits, and often only a title was submitted, without the manuscript itself or even the abstract. The secretary of Section N at that time felt that in order to have programs of high quality it would be necessary to emphasize certain subjects at each meeting and to obtain the best advice possible in selecting the persons to contribute to the subject. We have found this quite a simple plan to develop. In the first place, the secretary must be familiar with present-day problems in the field. After the subject of the symposium is chosen, an unofficial advisory group, actively engaged in research in the field, is appointed and consulted. With the advice of this committee, a group of contributors is then selected to discuss the various phases of the subject and those chosen are invited formally to present their work.

The plan outlined above has not only succeeded in a very important way in developing this forum of scientific medicine within the association, but it has increased the interest of medical men in the work of the association and has placed the meetings of Section N among the best in the country dealing with medical science.

The following series of symposia meetings of Section N have been held over the past few years:

June, 1934, Berkeley, "General Symposium on the Hormones, including Insulin."

December, 1934, Pittsburgh, "Symposium on Poliomyelitis"; "Symposium on the Chemistry and Metabolism of Sulfur Compounds."

June, 1935, Minneapolis, "Symposium on Blood Dyscrasias."

December, 1935, St. Louis, "Symposium on the Sex Hormones."

June, 1936, Rochester, "Symposium in Memory of Theobald Smith."

December, 1936, Atlantic City, "Symposium on Cancer."

June, 1937, Denver, "Symposium on Acid-Fast Bacterial Diseases—Tuberculosis, Leprosy, etc."

Up to the present time, seven of these so-called symposia meetings have been held by Section N. Gradually many refinements have been evolved, and the section now plans meetings ahead for a two-year period. At the coming meeting at Indianapolis, a very comprehensive program dealing with the general subject of syphilis is being arranged. Dr. Thomas Parran, Jr., Surgeon General of the United States Public Health Service, will bring this meeting to a close with an evening address on December 30. The secretary of Section N, Dr. Malcolm H. Soule, of the University of Michigan, is developing a general program for the Ottawa meeting in June, 1938, with our scientific and medical colleagues in Canada. For the December meeting in 1938 he is planning a most important symposium on mental health, and a special committee of the National Committee for Mental Hygiene is advising, with the active planning by Dr. Walter Lewis Treadway, to bring this gigantic problem before the association and the nation. Plans are already being discussed for the meeting of Section N for December, 1939, and another broad, important and nationally significant medical subject will be presented at this meeting.

Naturally the most important single factor in developing scientific programs of the high level described is the secretary of the section. Section N has been most fortunate in having as its secretary in recent years such men as Dr. Vincent du Vigneaud and, at present, Dr. Malcolm H. Soule.

EARL B. MCKINLEY

GEORGE WASHINGTON UNIVERSITY
SCHOOL OF MEDICINE

GIFTS OF LORD NUFFIELD TO THE
UNIVERSITY OF OXFORD

LORD NUFFIELD has offered the University of Oxford £1,000,000 (including a site valued at £100,000) for the building and endowment of a new graduate college, to be devoted to the collaboration, particularly in social studies, of theoretical students and practical men of affairs.

Two further gifts, making a total new benefaction of £1,300,000, also have been announced. These are £100,000 for the erection and equipment of a new laboratory of physical chemistry, and £200,000 for the erection of buildings at hospitals associated with the medical research scheme endowed by Lord Nuffield last year.

In making these gifts to the university, Lord Nuffield wrote:

Although I can not claim any expert knowledge of university policy, I have gathered from such observations as I have been able to make that it is not the desire of universities generally to compete with one another for pre-eminence in every branch of science. But felicitous appointments, opportune benefactions or other happy accidents from time to time stimulate particular developments. I understand that one branch of physical science with which the name of Oxford is particularly associated at present is physical chemistry, and I am aware of the importance of that subject in relation to other sciences which are of special concern to industrialists. Having heard of the unsatisfactory conditions in which the physical chemists in Oxford are obliged to work, I should be happy to give the university a sum sufficient for the building and equipment of an up-to-date laboratory of physical chemistry.

It is not, however, in the scientific branches alone that the universities are often unable to meet the demands of industry. In the meeting of the demands for new knowledge in the non-scientific subjects there is an even greater lag than in scientific subjects between research and its practical application. This is in some respects comparable with the separation between the clinical and the laboratory aspects of medical science which recent developments in Oxford are designed to bridge. Struck by this analogy, I have been wondering during the past year whether there is any way to bridge the separation between the theoretical students of contemporary civilization and the men responsible for carrying it on; between the economists, the political theorist, the student of government and administration on the one hand, and on the other hand the business man, the politician, the civil servant and the local government official, not to mention the ordinary every-day man and woman.

It is also announced that Lord Nuffield has made a gift of £300,000 to the Radcliffe Infirmary, Oxford. This is his second large donation to the infirmary, having already given £150,000. He has also placed £100,000 in the hands of trustees for the development of orthopedic surgery, and an organized service for the early discovery and the cure of crippling disabilities on a carefully considered plan in South Africa. The organization will be based on information to be gathered and collated by Professor G. R. Girdlestone, who will visit South Africa for the purpose during December and January.

GIFT FOR THE STUDY OF ARTHRITIS AT THE UNIVERSITY OF MICHIGAN

MADE possible by an endowment grant of \$1,000,000 from the Horace H. Rackham and Mary A. Rackham Fund, a comprehensive study of arthritis, its prevention, cure and mitigation, will be conducted at the University of Michigan. This research project, under the terms of the gift, will be continued for at

least five years, and may be continued for ten years if the Board of Governors of the Horace H. Rackham School of Graduate Studies so decides. It is in addition to the other large gifts which have come to the University of Michigan from this source; gifts which have made possible the erection of the new Horace H. Rackham School of Graduate Studies Building, now nearing completion, and the large endowment of that school; the gift that made possible the establishment of the Institute for Human Adjustment, and other donations to this and to other institutions.

Preliminary announcement of this latest gift was made several months ago when it was stated that the sum of \$10,000 would be available for the study of arthritis. At that time the research organization was tentatively set up and preliminary studies started. The original \$10,000 will be merged into the amount expendible for the first year of the research.

The gift funds which endow the research have been set up by the Board of Regents as the Rackham Arthritis Research. The interest will be used annually to finance the research activities. These funds will be cumulative and any amount not used in a fiscal year will be available for the following year.

Following the arthritis study, the executive board may direct that the available funds be used for some other major research project. At any time after fifteen years, the whole sum may be added to the endowment fund of the Horace H. Rackham School of Graduate Studies, where it will be used continuously for research projects and other allied activities.

Preliminary work has been going forward rapidly since the first grant of \$10,000 was made. The members of the executive committee are: Dr. Cyrus C. Sturgis, professor of internal medicine, director of the Simpson Memorial Institute for Medical Research and director of the department of internal medicine in the Medical School, chairman; Dr. Harley A. Haynes, director of the University Hospital, and Dr. Carl E. Badgley, professor of surgery and head of orthopedics in the department of surgery in the Medical School. Dr. Richard H. Fryberg, assistant professor of internal medicine, has been relieved from teaching and has been appointed director of the research.

AWARD OF THE WILLIAM H. PERKIN MEDAL

DR. FRANK J. TONE, president of the Carborundum Company, Niagara Falls, N. Y., father of Franchot Tone, motion picture actor, has been awarded the William H. Perkin Medal of the American Section of the Society of Chemical Industry for 1938 for "valuable work in applied chemistry, including the development of abrasives and refractories."

The medal will be presented at a joint meeting of

the American Section of the Society of Chemical Industry and the American Chemical Society on January 7, at The Chemists' Club. Professor Marston Taylor Bogert, of Columbia University, will make the presentation. The official statement of the reasons for conferring the medal reads:

Dr. Tone's innumerable contributions to the development and perfection of practicable and commercial processes in the field of applied chemistry extend their benefits to the field of all useful arts. He has played the key part in building up from humble beginnings two major industries—synthetic abrasives and refractories—which, although related, are widely divergent in their manufacturing practice and fields of application. He discovered silicon monoxide, fibrous silicon oxycarbide and electric furnace mullite and spinel. He was a pioneer in the commercial development of synthetic abrasives and refractories, particularly silicon carbide and silicon carbide resistor elements.

Dr. Tone is a former president of the American Electrochemical Society and a member of the American Chemical Society, the American Institute of Chemical Engineers, the American Ceramic Society, the Society of Chemical Industry in London, the American Institute of Mining and Metallurgical Engineers and Phi Kappa Psi. He was the first recipient of the Jacob F. Schoellkopf Medal of the Western New York Chapter of the American Chemical Society in 1931. The American Electrochemical Society conferred on him the Edward Goodrich Acheson Medal in 1935. He also received medals at the Paris Exposition in 1900, the Pan American Exposition in 1901 and the St. Louis Exposition in 1904.

The Perkin Medal was founded in 1906 in commemoration of the fiftieth anniversary of the coal tar color industry, the first medal being awarded to Sir William H. Perkin, discoverer of aniline dyes. The medalist is chosen by a committee representing the American Section of the Society of Chemical Industry, the American Chemical Society, the Electrochemical Society, the American Institute of Chemical Engineers and the Société de Chimie industrielle.

Former Perkin medalists besides Sir William Perkin have been: J. B. F. Hemeshoff, Arno Behr, E. G. Acheson, Charles M. Hall, Herman Frasch, James Gailey, John W. Hyatt, Edward Weston, L. H. Baeckeland, Ernest Twitchell, A. J. Rossi, F. G. Cottrell, Charles F. Chandler, Willis R. Whitney, William M. Burton, Milton C. Whitaker, Frederick M. Becket, Hugh K. Moore, R. B. Moore, John E. Teeple, Irving Langmuir, E. C. Sullivan, Herbert H. Dow, Arthur D. Little, C. F. Burgess, George Oenslager, G. O. Curme, Jr., Colin G. Fink, Warren K. Lewis, Thomas Midgley, Jr.

AWARD OF THE JOHN FRITZ GOLD MEDAL

DR. PAUL DYER MERICA, director of research of the International Nickel Company and vice-president of the International Nickel Company of Canada, has been awarded the 1938 John Fritz Gold Medal for "important contributions to the development of alloys for industrial uses." The award is made annually for notable scientific or industrial achievement by a board composed of representatives of the four national engineering societies of civil, mining and metallurgical, mechanical and electrical engineers.

The official statement points out that Dr. Merica's extensive research in theoretical and practical metallurgy has increased scientific knowledge in both ferrous and non-ferrous fields. He has contributed generously to the science of metals, his work having covered the magnetic mechanical properties of steel, railway materials; failure of brass; the constitution, manufacture and application of light alloys of aluminum; heat treatment of cast aluminum alloys; the precipitation theory of hardening of metals, and nickel and nickel alloys.

Dr. Merica was born in Warsaw, Ind., on March 17, 1889. He studied from 1904 to 1907 at De Pauw University, which in 1934 conferred upon him the degree of doctor of science. In 1909 he received the bachelor of arts degree from the University of Wisconsin, and in 1914 the Ph.D. degree from the University of Berlin. Following five years of work as research physicist in the U. S. Bureau of Standards, he became in 1919 director of research of the International Nickel Company.

Dr. Merica is a fellow of the American Association for the Advancement of Science, and a member of the American Chemical Society, the Electrochemical Society, the American Society for Testing Materials, the American Physical Society, the American Institute of Mining and Metallurgical Engineers, the American Institute of Civil Engineers, the Washington Academy of Sciences, the Institute of Metals, the Iron and Steel Institute, the Canadian Institute of Mining and Metallurgy and Deutsche Gesellschaft für Metallkunde. He is the author of many articles and monographs in scientific and technical publications. In 1929 he received the James Douglas Medal.

Among the thirty-three previous recipients of the John Fritz Medal were Lord Kelvin, Thomas Edison, Guglielmo Marconi, Elihu Thomson, John R. Freeman, John F. Stevens, Elmer A. Sperry, Daniel C. Jackling, Michael I. Pupin, J. J. Carty, J. Waldo Smith, Frank Julian Sprague, William Frederick Durand and Arthur N. Talbot.

The Board of Award was composed as follows:

American Society of Civil Engineers—Alonzo J. Hammond, George S. Davison, Arthur S. Tuttle, Daniel W. Mead.

American Institute of Mining and Metallurgical Engineers—Frederick M. Becket, Howard N. Eavenson, Henry A. Buehler, John M. Lovejoy.

American Society of Mechanical Engineers—A. A. Potter, Paul Doty, Ralph E. Flanders, William L. Batt.

American Institute of Electrical Engineers—John B. Whitehead, Arthur W. Berresford, A. M. MacCutcheon.

RECENT DEATHS AND MEMORIALS

DR. WILL SCOTT, professor of zoology at Indiana University, died on October 17 at the age of sixty years. Dr. Scott is known for his work in Indiana caves and lakes. He was a past president of the Indiana Academy of Science.

DR. LOUIS GROSS, director of the laboratories of Mount Sinai Hospital, New York City, was killed in the United Air Lines plane disaster in northeastern Utah on October 17. He was forty-two years old.

COLONEL DAVID ALEXANDER LYLE, retired engineer

and inventor, died on October 12 at the age of ninety-two years.

DR. HAROLD BENJAMIN FANTHAM, Stratheona professor of zoology at McGill University, died on October 26 in his sixty-second year.

SIR JOHN THOMSON-WALKER, British surgeon, a specialist on urological diseases, died on October 6 at the age of sixty years.

A MEMORIAL service was held at Cornell University on October 18 in honor of the late Professors Cyrus R. Crosby and Peter W. Claassen. The speakers included Professor James G. Needham, emeritus, and Professor Liberty Hyde Bailey, emeritus.

Nature states that J. W. O. Hamilton, who has offered sums to found prizes for radio research at the Universities of Cambridge, Melbourne, Sydney and Tasmania, has written to the vice-chancellor of the University of Cambridge, offering the sum of £500 for this purpose. Mr. Hamilton has expressed a desire that the names of James Clerk Maxwell and Sir Ambrose Fleming, both Cambridge men, should be associated with the prize.

SCIENTIFIC NOTES AND NEWS

AN Associated Press dispatch dated from Stockholm on October 28 reports that Dr. Albert von Szent-Györgyi, professor of medicine at Szeged University, Hungary, has been awarded the Nobel Prize for Physiology and Medicine for 1937, in recognition of "his discoveries on the biological process of combustion, especially in relation to vitamins A and C."

DR. SIMON FLEXNER, George Eastman visiting professor at the University of Oxford, has been elected to a professorial fellowship at Balliol College. Others elected were Professor J. A. Gunn, director of the Nuffield Institute of Medical Research, and Professor J. H. Burn, who succeeded Professor Gunn in the chair of pharmacology.

DR. LOUIS ALAN HAZELTINE, professor of mathematics at the Stevens Institute of Technology, at the annual dinner in New York City of the Radio Club of America on October 29 was presented with the Armstrong Medal and citation for 1937 "in recognition of his outstanding contributions to the art and science of radio communication." He is the first to receive the award, which was established by the Radio Club in 1935 in honor of the achievements of Major Edwin H. Armstrong, professor of electrical engineering at Columbia University.

THE Cuban Order of Carlos Manuel de Cespedes has been conferred on Van Campen Heilner, field representative of the department of ichthyology of

the American Museum of Natural History, in recognition of his friendship for the Cuban people and for the work that he has done to promote game fishing in that country.

HENRY R. LUCE, president of Time, Inc., was presented with the first Clement Cleveland Medal of the New York City Cancer Committee of the American Society for the Control of Cancer at a dinner given on October 21 at the Town Hall Club. The medal, awarded for "outstanding work during the year in the campaign to control cancer," was in recognition of the "March of Time" sequence on "Conquering Cancer," and for articles on the subject in *Time*, *Life* and *Fortune*.

THE gold medal of the Medical Association of South Africa (affiliated with the British Medical Association), awarded for "meritorious services rendered to the profession," has been given to Dr. William Thomas Frederick Davies, of Natal, president of the South African Medical Council.

At the thirty-third annual meeting of the directors of the National Association of Audubon Societies, held in New York City on October 26, Dr. Robert Cushman Murphy, of the American Museum of Natural History, was elected president, to succeed Kermit Roosevelt. At the annual meeting of the Long Island Biological Association, held at Cold Spring Harbor on Septem-

ber 17, Dr. Murphy was elected a member of the board of directors for a four-year period.

At the Chicago meeting of the American College of Surgeons Dr. Howard C. Naffziger, professor of surgery at the Medical School of the University of California, was elected president for 1938-39; Dr. Vernon C. David, of Chicago, was elected vice-president, and Dr. Fraser B. Gurd, of Montreal, second vice-president.

D. ROBERT YARNALL, chief engineer of the Yarnall-Waring Company of Philadelphia, has been elected president of United Engineering Trustees, joint agency of the four founder societies of civil, mining and metallurgical, mechanical and electrical engineers. Mr. Yarnall succeeds George L. Knight, vice-president of the Brooklyn Edison Company.

At the meeting of the Section of Psychology of the New York Academy of Sciences on October 18, Dr. Irving Lorge, of Teachers College, Columbia University, was elected chairman to succeed Dr. Jack Dunlap, of the University of Rochester, and Dr. Anne Anastasi, of Barnard College, was elected secretary. Dr. George Hartmann, of Teachers College, Columbia University, addressed the section on "The Organization of Attitudes." Dr. Karl Lashley, of Harvard University, will deliver a lecture on "The Neurology of Vision" at the meeting to be held on November 15 at 8:15 P. M., at the American Museum of Natural History. Immediately following the lecture, there will be a reception in honor of Dr. Lashley.

DR. CHARLES H. TOWNSEND, director of the New York Aquarium, retired on November 1, the thirty-fifth anniversary of his appointment in 1902. Dr. Charles M. Breder, Jr., research associate, has been appointed acting director of the aquarium.

DR. CARL LUCAS ALSBERG, formerly director of the Food Research Institute of Stanford University and previously chief of the U. S. Bureau of Chemistry, has been appointed director of the Giannini Foundation of the University of California in succession to Professor H. R. Tolley, now administrator of the Agricultural Adjustment Administration. Dr. Alsberg will without remuneration act as adviser to the Food Research Institute of Stanford University, in order that the parallel studies being made of agricultural economics in the state by the two institutions may be given the greatest possible impetus. Dr. Alsberg took up his new work on October 19.

PROFESSOR P. J. PARROTT has been made director of the New York State Experiment Station at Geneva, effective on January 15 upon the retirement of Dr. U. P. Hedrick, present director. Professor Parrott has been vice-director of the station since 1928.

FACULTY changes at the University of Pennsylvania, as reported in the *Journal* of the American Medical Association, include: Dr. Earl D. Bond, professor of psychiatry in the Graduate School of Medicine, has been appointed vice dean, and Dr. Detlev W. Bronk, professor of neurology and Eldridge Reeves Johnson professor of biophysics, has been appointed vice dean in neurology. Dr. Leon Herman has been appointed professor of urology in the Graduate School. Dr. John H. Jopson retires with the rank of emeritus professor of surgery.

DR. HOWARD J. SHAUGHNESSY, formerly director of laboratories of the Illinois State Board of Health at Springfield, has resigned to become associate professor of bacteriology and public health at the School of Medicine and Hospitals of the University of Colorado at Denver.

TEMPORARY reorganization of the administration of the College of Engineering of Cornell University, made necessary by the death of Dean Herman Diederichs, has been made as follows: Professor S. C. Hollister, acting dean of the college; Professor Paul M. Lincoln, acting director of electrical engineering, and Professor William N. Barnard, acting director of mechanical engineering; Professor Paul H. Underwood, acting director of civil engineering.

THE Philadelphia College of Pharmacy and Science has appointed Dr. Howard S. Kaltenborn, of the University of Michigan, assistant professor of mathematics, and Dr. Donald P. Le Galley, of the University of California, assistant professor of physics.

DR. GEORGE M. SAUNDERS, for the past five years head of the Yaws Commission in the British West Indies of the Rockefeller Foundation, has been appointed by the Leonard Wood Memorial director of a newly established department to make a study of the environmental factors affecting lepers.

DR. A. BAIRD HASTINGS, Hamilton Kuhn professor of biochemistry in the Harvard Medical School, has been appointed a member of the Medical Fellowship Board of the National Research Council for the period ending June 30, 1941, to complete the unexpired term of membership of Dr. Walter B. Cannon, who has resigned.

PROFESSOR J. H. GADDUM, professor of pharmacology at University College, has been appointed director of the pharmacological laboratories of the College of the Pharmaceutical Society in succession to Dr. J. H. Burn, who was recently appointed professor of pharmacology at the University of Oxford.

PROFESSOR ELIOT BLACKWELDER, of Stanford University, returned recently from a sabbatical year in

Europe and Egypt and will resume his work at the university about the end of November.

DR. PHILIP S. SMITH has returned to the United States after the completion of his work as chairman of the American delegation to the Seventeenth International Geological Congress at Moscow, in the course of which he participated in geologic excursions organized by the congress into the Caucasus region and the western part of Siberia. He returned *via* eastern Siberia, Japan and Hawaii.

DR. WILLIAM BEEBE is setting out on the twenty-sixth expedition for the department of tropical research of the New York Zoological Society. With three of his staff he will be met at San Diego by Templeton Crocker on board the yacht *Zaca*. This vessel has again been placed at the disposal of Dr. Beebe for the winter. Two years ago the first *Zaca* expedition resulted in interesting discoveries in the Gulf of California. Now, the study of the shallow-water and deep fishes down to a mile or more will be begun at Manzanillo and will be continued slowly southward along the coasts of Mexico, Guatemala, El Salvador, Nicaragua and Costa Rica to Panama. Particular attention will be paid to whale sharks, which are abundant in certain places, and in the specific relationship between Atlantic and Pacific fish. As before, concentrated work will be carried on in a few rich places.

DR. EINAR LUNDSGAARD, of the Institute of Medical Physiology, University of Copenhagen, will deliver the second Harvey Society Lecture of the current series at the New York Academy of Medicine on November 18. He will speak on "The Pasteur-Meyerhof Reaction in Muscle Metabolism."

DR. MARSTON TAYLOR BOGERT, professor of organic chemistry at Columbia University, was the guest of honor of the Smith College Chapter of Sigma Xi at a dinner given on October 22. Following the dinner he delivered an illustrated lecture entitled "Perfumes—Natural, Synthetic and Artificial."

DR. KARL T. COMPTON, president of the Massachusetts Institute of Technology, was one of the principal speakers at the twenty-second annual conference in Boston of the Associated Industries of Massachusetts.

PROFESSOR ONDESS L. INMAN, director of the C. F. Kettering Foundation for the Study of Chlorophyll and Photosynthesis, lectured on "Photosynthesis Research" on October 18, under the auspices of the Midland Michigan Section of the American Chemical Company, before the staff of the Dow Chemical Company at Midland.

APPLICATION blanks and a circular of information

concerning the tenth International Congress of Chemistry, to be held at Rome from May 15 to 21, may be obtained by writing to the Division of Chemistry and Chemical Technology, National Research Council, 2101 Constitution Avenue, Washington, D. C.

FELLOWSHIPS in the Medical Sciences, administered by the Medical Fellowship Board of the National Research Council, of which Dr. Francis G. Blake, of Yale University, is chairman, will be available for the year beginning on July 1, 1938. These fellowships are open to citizens of the United States and Canada who possess an M.D. or a Ph.D. degree. They are intended for recent graduates and not for those already professionally established. Fellows will be appointed at a meeting of the Medical Fellowship Board about March 1. Applications to receive consideration at this meeting must be filed on or before January 1. Appointments may begin on any date determined by the board. Further particulars may be obtained by addressing the Secretary of the Medical Fellowship Board, National Research Council, 2101 Constitution Avenue, Washington, D. C.

SECTION E of the American Association for the Advancement of Science will meet in Indianapolis on December 31 and January 1. A symposium on the petroleum geology of the Illinois-Indiana-Kentucky basin has been arranged for December 31. Papers dealing chiefly with the stratigraphy, physiography and geography of the Till Plains, Eastern Lake Section, and Interior Low Plateaus will be presented at the other sectional meetings. The secretary of the section is Howard A. Meyerhoff, 88 Crescent Street, Northampton, Mass.

THE autumn meeting of the New England Conference of the American Association of Museums will be held at Boston and Cambridge, Mass., on November 18 and 19. On the first day sessions on art will be held at the Museum of Fine Arts, Boston, and on science at the New England Museum of Natural History. On the second day, both art and science groups will meet at Harvard University. Conference headquarters will be at the Museum of Fine Arts.

THE thirteenth annual meeting of the Cotton States Branch of the American Association of Economic Entomologists will be held in the Jung Hotel at New Orleans, from February 3 to 5. Titles of papers for the program should be mailed to Oliver I. Snapp, secretary of the branch.

THE second conference on methods in philosophy and the sciences will be held under the auspices of the New School for Social Research, New York City, on Sunday, November 28. The first session will be opened at 12:30, when Dr. John Dewey will present a me-

morial to F. C. S. Schiller (1864-1937). Following there will be a symposium on the Concept of Law in the Mathematical and Natural Sciences, in which Morris R. Cohen, of the College of the City of New York, will speak on philosophy; D. J. Struik, of the Massachusetts Institute of Technology, on mathematics and physics, and Otto Glaser, of Amherst College, on biology. In the afternoon there will be a symposium on the Concept of Law in the Social Sciences, in which R. H. Lowie, of the University of California, and Alexander Lesser, of Columbia University, will represent anthropology, and George A. Lundberg, of Bennington College, sociology.

A MEETING of the New York Geographical Association at the State Normal School, Cortland, N. Y., will be held on Saturday, November 13. During the morning session a series of papers will be presented, and a land use field trip will be conducted during the afternoon. Dr. George B. Cressey, of Syracuse University, will give an account at the annual banquet of his work in Siberia during the past summer.

THE annual meeting and dinner of the U. S. Institute for Textile Research has been postponed from November 4 to Friday, November 12, at the Hotel Commodore, New York City. Textile Research Progress will be the subject of papers and addresses at an open research conference in the afternoon and at the dinner, and results of researches of the Textile Foundation, the Chemical Foundation, the American Association of Textile Chemists and Colorists, and the U. S. Institute will be described. The study of Organization of Production and Distribution in the Textile Industries, now nearing completion at the Wharton School of Finance and Commerce, Philadelphia, Pa.,

will be described at the dinner on Friday evening by Dean Joseph H. Willits and his associates, Messrs. Balderston, Taylor and Davis, and Dr. Wanda K. Farr, of the Chemical Foundation, will report progress on research on the chemistry of cellulose. The Hon. Francis P. Garvan, president of the U. S. Institute for Textile Research and of the Chemical Foundation, will preside at the dinner, and the first vice-president, Dr. E. H. Killheffer, will act as toastmaster. W. E. Emley, chairman of the Research Council, will preside at the afternoon conference.

At the recent meeting of the annual clinical congress of the American College of Surgeons in Chicago, Dr. Max Cutler, director of the Tumor Clinic of Michael Reese Hospital, announced the establishment of the Chicago Tumor Institute "to conduct research on the causes, diagnosis and treatment of cancer, and to instruct and assist physicians, surgeons, clinics and hospitals in the diagnosis and treatment of cancer." Associated with Dr. Cutler in the direction of the institute will be: Dr. Ludvig Hektoen, director of the McCormick Memorial Institute for Infectious Diseases of the University of Chicago, *president*; Dr. Arthur H. Compton, professor of physics, University of Chicago, *vice-president*; Dr. Henri Coutard, of the Curie Institute, Paris, and Sir Lenthal Cheatele, of London. Plans have been completed for the remodeling of the building at the southeast corner of Dearborn and Elm Streets, which will house the activities of the institute. It will be ready for occupancy and the institute will begin to function about March 1. Dr. Coutard plans to arrive on November 10 and to spend three months in research at the California Institute of Technology.

DISCUSSION

THE PERENNIAL FLYING FISH CONTROVERSY

THE method of operation of the mechanism involved in the aerial travels of the oceanic flying fishes (*Exocoetidae*) would seem to be beyond solution if one were to judge from the perennial blooming of the controversy concerning the alleged possibility of a wing-flapping flight. Those of us who, on a basis of aerodynamics, observation and anatomy, have long been satisfied that the flight of these fishes is in the nature of that of a motorless glider, are sometimes at a loss to understand the point of view of those who continue to believe that simple observation alone can be used to establish a flapping flight without any reference to the limitations of the motor mechanism necessarily involved or to the principles of modern aerodynamics. As long ago as 1930¹ the writer decided

to make no further attempt to answer such comments as appear on the subject from time to time. However, the most recent attempt² to establish wing-flapping for flying fish has caused a reconsideration of that decision for reasons that should be sufficiently obvious in the following discussion.

In this most recent case, there is a list of seven items in support of the wing-flapping belief. These are here repeated and each is subtended by such comments as the individual items require.

"The course was not a trajectory, but flat." No one has thought to consider these fish as simple projectiles. The feats of modern gliders to which these fish, on the other hand, have been compared are certainly not trajectories and may be just as "flat" as those of any flying fish. Many birds, *e.g.*, the albatross, although

¹ C. M. Breder, Jr., *Copeia*, 4: 114-121, 1930.

² E. L. Troxell, *SCIENCE*, 86: 177-178, 1937.

capable of wing-flapping, manage to out-glide any flying fish in an identical environment without any recourse to wing-flapping. Such movements are brought into play for other purposes. As flying fish are unable to produce such movements, when they find themselves in similar circumstances they are either forced down or manage to keep aloft by other manipulations.³

"The angle of emergence, probably 5° to 7° ." The angle of emergence is perforce conditioned by the fish's behavior and ability as a swimming mechanism. While the resulting flight is undoubtedly influenced by the angle of emergence, there is nothing intrinsic in this angle to either preclude a soaring flight or to favor a wing-flapping one. A glider may be snapped into the air at a much higher angle or may be towed to flying speed at one much lower. It is the latter type of take-off that the fish so often simulate in their well-known "taxi" movements in which only the lower caudal lobe remains immersed. The details of this movement are well known and have been figured and described in the fullest detail by Hubbs (1933).⁴

"There was apparently uniform speed." The speed may be regulated by changing the camber of the wings, a feat no glider is built to accomplish, but one which gives the fish a much greater flexibility of flight and a generally smoother performance. Even so, marked variation in speed in straight-away flight is not a notable feature of gliders.

"The fishes turn in their flight." So may anything with a rudder. Further, much of the curving in the flights of flying fish is caused by extrinsic wind pressures forcing the fish to swerve.⁵ This item and all those preceding raise questions that could equally well be asked concerning the behavior of a glider or a soaring bird if there remained in the minds of any one a query regarding the possibility of a hidden interior source of power.

"The wings seemed to flutter." If viewed from directly behind, the "flutter" resolves itself into a side-to-side, rocking motion on the longitudinal axis, the right wing tip being up when the left is down, a condition not compatible with an ordinary flapping flight. This condition of instability is, however, one associated with the large lateral dihedral angle between the wings that these fish use in initiating a flight in order to obtain a maximum lift. In a fair breeze or when flying speed has been sufficiently increased by any means, the wings are customarily lifted a little, decreasing the lateral dihedral and increasing stability

at the expense of some lift, a loss proportionally permissible in ratio to the increased speed of translation.⁶

"There was flight in both calm and rough weather." Flights are longer, higher and more sustained with a light breeze than in a dead calm.^{1, 4, 5} Flight in a dead calm is least and is induced by the taxi maneuvers in which flying speed is attained.

"There was a distinct runway in the take-off." This apparently refers to what has been more generally called the taxi. Both flapping birds, such as gulls, planes and gliders, use analogous methods to get into the air with flying speed. This item, like the rest, can not be used to distinguish one kind of flight from the other.

In the text of the article under discussion, mention is made of the appearance on the surface of the water of two parallel rows of dots and is described as "... undoubtedly made by the tips of the fluttering wings before the fish had completely cleared the surface." If indeed the "dots" were caused by the wing tips, a change of the word "fluttering" to "oscillating" would satisfy this writer. This would stagger the dots instead of placing them in the pairs that Troxell illustrates. Since, however, the "dots are ever expanding Newton's rings in close series, it is difficult to estimate just how accurate such an observation might be. The writer once thought he detected some such disturbance in very calm weather, but the larger rings made by the rapidly oscillating caudal fin so far obscured them that certainty was not possible. Forbes,⁷ observing flying fish from an airplane, describes surface marks as follows: "... I distinctly saw the undulating wake of the fish's tail, looking like a row of dots on the surface of the water." Could it be that the "dots" of the tail were mistaken by the more recent observer for pectoral dippings? It may be mentioned that Troxell made no reference to the rapidly beating tail fin with its lower lobe trailing in the water, a most conspicuous feature of the take-off. One wonders what function this violent muscular activity serves if the fish is fluttering its way aloft.

The pectoral musculature, from an anatomical side, has been shown long ago to be in no way adequate to the demands of wing-flapping exertion.⁸ There is nothing in the nature of a sternum-like structure for the necessary attachment nor a muscle mass in any way sufficient for the work required. All flying animals employing a wing-flapping mechanism, bats, birds or pterodactyls, have necessarily the required large power plant.

It is worth noting in this connection that the tiny fresh-water characid flying fishes of the subfamily

³ C. M. Breder, Jr., *loc. cit.*

⁴ C. L. Hubbs, *Pap. Mich. Acad. Sci. Arts and Letters*, 17: 575-611, 1933.

⁵ C. M. Breder, Jr., *Zoologica*, 9: 295-312; 1929; C. L. Hubbs, *Smiths. Rep.*: 333-348, 1935, and *Pap. Mich. Acad. Sci. Arts and Letters*, 22: 641-660: 1937.

⁶ C. M. Breder, Jr., *Copeia*, 4: 114-121, 1930.

⁷ A. Forbes, *SCIENCE*, 83: 261-262, 1936.

⁸ W. G. Ridewood, *Ann. Mag. Nat. Hist.*, 8: 544-548, 1913.

Gasteropelecinae have a well-developed sternum-like process and a muscle mass attached to it that should certainly be adequate for a wing-propelled flight.^{9, 10} Field observations of *Thoracocharax maculatus* (Steindachner) could not satisfy the writer if such was the case.^{11, 12} These flights were only seen at night by aid of a flashlight and were of such erratic occurrence that details of this sort could not be distinguished. On an anatomical basis it may well be, however, that here alone, in the fishes, is to be found a true wing propelled flight. If such is the case, the small size of these fishes and the failure to see any evident flapping in field observation leads one to incline to the idea that such wing movement might well approach to the mechanics of a buzzing insect flight. Against this is the form of the pectorals which are surprisingly similar to those of the exocoetids, and quite unlike any insect wing.¹³ Since the field observations were made, other species in aquaria and in a fairly large outdoor pool have been experimented with in an attempt to study the flight to better advantage. So far a simple leap, such as a variety of fish might make, has been the only result. In the field it was quickly found that these fish would not fly unless there was water ahead of them; in other words, they could not be forced to fly ashore. Just how they knew when there was and when there was not open water ahead is not understood, but may be basic to their refusal to fly in small aquaria. This should not apply to the pool in question, which has two arms, each over twenty feet in length.

No longer ago than last year, a similar controversy took place on these very pages which the writer purposely refrained from entering. This was instigated by Mills¹⁴ and adequately answered by Forbes¹⁵ and Loeb.¹⁶ Considering the literature alone since 1930 there have appeared four critical dissertations—three by Hubbs already referred to of some length, and one by Carter and Mander.¹⁷ The earlier literature, running back to before the time of an adequate aerodynamic basis, need not be discussed here, except to say that it is of great volume and of large variation in quality. A lead into its vastness may be had from the bibliographies in the more recent papers mentioned herewith. In the light of this, it seems unfortunate that field naturalists continue to present the anachronism of explaining why and how the oceanic

flying fishes flap their wings to locomotor effect on a basis of more or less extended shipboard observation without bothering to take into consideration two fundamental elements involved; namely, that of mechanical possibility on an anatomical basis and that of the aerodynamic possibility on an engineering basis. There is adequate data to show that all the performances noted in the Exocoetidae are well in accord with the calculable limits of their aerodynamic characteristics as gliders.

C. M. BREDER, JR.

NEW YORK AQUARIUM

HOME OF THE ANCON SHEEP

IN Darwin's "Animals and Plants under Domestication," Chapter 3, he refers to the ram lamb born in Massachusetts in 1791 with short crooked legs, like a turnspit dog, which was the ancestor of the Otter or Ancon, a semi-monstrous breed, valued because they could not leap over fences; since exterminated. His statement is based on the report of Colonel Humphreys, *Philosophical Transactions*, London, 1813, page 88. This achondroplastic character was perhaps recessive, because the Otter ram and ewe always produced Otter offspring (except one questionable case). I do not know of other published first-hand statements on the Otter sheep.

In May, 1899, while I lived in Cambridge, I paid a visit to Dover, Mass., and interviewed Mr. Frederick Wite, grandson of Seth Wite, Jr., the originator of the Ancon or Otter race of sheep; also Mr. George Ellis Chickering, of Dover, and his brother. In a graveyard I found a stone with the inscription, "Mr. Seth Wite Jun^r Who Died July, 1799, Aged 46."

Mr. Chickering, who was probably about 65, stated that his father, who died in 1857, had Otter sheep, which he disposed of just before his death, and Mr. Chickering's father told him they were Otter sheep of Mr. Wite's breed. Mr. Chickering did not know of any Otter sheep later than this. He remarked that the sheep had peculiar crooked legs and thought likely they could not jump fences as well as other sheep, though his brother, standing by, said they would jump fences on occasion.

Mr. Wite's farm was on the Charles River, about three miles southwest of the village of Dover, near the Sherborn line—Latitude 42° 14' 15" N; Longitude, 71° 19' 30" W. This Frederick Wite, who appeared to be about 70 years old, knew that his grandfather, Seth Wite, Jr., had originated the Otter sheep, but knew nothing more about it. Mr. Wite, like Mr. Chickering, had never heard the name Ancon (only Otter) applied to these sheep.

CHAS. B. DAVENPORT

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⁹ *Ibid.*

¹⁰ C. M. Breder, Jr., *Bull. Amer. Mus. Nat. Hist.*, 57: 91-176, 1927.

¹¹ *Ibid.*

¹² C. M. Breder, Jr., *Zoologica*, 4: 159-297, 1926.

¹³ *Ibid.*

¹⁴ C. A. Mills, *SCIENCE*, 83: 80 and 262, 1936.

¹⁵ A. Forbes, *SCIENCE*, 83: 261-262, 1936.

¹⁶ L. B. Loeb, *SCIENCE*, 83: 260-261, 1936.

¹⁷ G. S. Carter and J. A. H. Mander, *Rep. Brit. Assn. Adv. Sci.*, 105: 383-384, 1935.

THE LIFE CYCLE OF A TREMATODE OF FROGS

THE life history of *Glypthelmins quieta* Stafford, 1900, has been experimentally determined. The cercaria, one of the ornate Xiphidiocercariae, has been identified as *Cercaria mesotyphla* Miller, 1935. Natural infections of this cercaria have been found in *Physa gyrina* and *P. gyrina hildrethiana* in the vicinity of Urbana, Illinois.

The amphibian genera *Rana*, *Hyla* and *Pseudacris* have been reported in the literature as definitive hosts for *G. quieta*. In the present study experimental infections have been secured in *R. pipiens* and *R. catesbeiana*.

The cercariae penetrate the skin of the amphibian and become encysted just beneath the outermost layer. They are cast off with the shed skin. The worms reach the digestive tract of the definitive host when the host ingests the cast skin.

The eggs of *G. quieta* are embryonated when they leave the uterus and hatch apparently only when eaten by the snail host. Miracidia as well as empty egg shells have been observed in the dissected gut of snails.

Experiments involving attempts to infect the tadpoles of *R. pipiens* and *R. catesbeiana* were negative. A detailed account of this life history will be published elsewhere.

W. HENRY LEIGH

UNIVERSITY OF ILLINOIS

AN EARLY REPORT OF LEAD POISONING IN WATERFOWL

THE writer recently had the privilege of visiting Harold H. Bailey, at Coral Gables, Florida, and of inspecting the extensive ornithological collection housed in Mr. Bailey's private museum.

During a discussion concerning waterfowl, Mr. Bailey stated that he had been district inspector of migratory birds for the U. S. Bureau of Biological Survey, a position authorized under the Lacey Act, during the period from 1913 to 1917. Under his supervision at that time were Virginia, the District of Columbia and parts of Maryland and North Carolina. As a part of his work in that position, Mr. Bailey said that he had done considerable work on the diseases of ducks, geese and swan, and had discovered, particularly in Back Bay, Virginia, and Currituck Sound, North Carolina, that they were being poisoned through ingesting lead shot, which remained in their gizzards until ground away, producing symptoms typical of lead poisoning, and ultimately death. He then demonstrated a large amount of material he had

gathered during the years mentioned. Many of the preserved gizzards contained over one hundred full-sized No. 4 lead shot, besides partly ground remains. He also showed the reports he had received from the Virginia state chemist at Richmond, who had examined the livers, intestines and muscle of the birds collected, and had reported evidences of lead poisoning.

Mr. Bailey further stated that he had forwarded a number of birds so poisoned to the Bureau of Biological Survey for examination, and that an account of this discovery of lead poisoning in waterfowl had appeared in the Richmond papers of that time and was extensively copied.

In view of the attention now being given to lead poisoning in water-fowl, Mr. Bailey's account of these activities and discoveries of over twenty years ago was especially interesting.

I. D. WILSON

VIRGINIA POLYTECHNIC INSTITUTE

IDEST: A WORD FOR AVOIDING AMBIGUITY

I HAVE used in some of my writings regarding the chemistry and technology of cereals the word "idest," which is simply a combination of the two Latin words *id* and *est*, in order to avoid the equivocal word "or," when it was desired to indicate the equivalence or essential synonymy of two different terms. It is a frequent occurrence to find, in scientific or descriptive literature, places where one is uncertain whether the word "or" is used as a disjunctive conjunction, meaning one or the other of two or whether it indicates equivalence. Frequently the context indicates which of the two senses of "or" is intended. For example, in Gortner's "Outlines of Biochemistry," it is clear that equivalence is intended in the following: "cephalin or kephalin," "aminoglucose or glucosamine," and "myricyl or melissyl alcohol occurs," and that non-equivalence is intended in the following: "by pancreatic lipase or by emulsin," "edestin or casein dissolve," "natural or acquired immunity." In these cases and others the number of the verb, the similarity in spelling, the context, the use of added expressions such as "else," "rather," "especially," or the use of parentheses or other punctuation, as used by the careful writer, leaves no doubt which of the two senses the writer intended, but it is not unusual to find, in the literature of science, cases where a reader, who may not be informed from some other source, finds great difficulty or can not possibly determine whether equivalence or alternativeness is intended. Not being familiar with the technology of weaving, I would like to know, but can not determine, whether the author of "Silk, the Queen of Fabrics," in the sentence "Grenadine . . . fabric of open texture, made in gauze or

leno weave," meant that leno weave is another name for gauze weave or that it is a different mode of weaving. Although in writing it is possible to set off with commas or parenthesize the synonymous expression, as for example "sucrose, or saccharose, is," or to use the rather awkward and interruptive expression "that is" or the abbreviated ("*i.e.*"), it seems that adoption of the Latin words combined as a single, short English word meets the demand for a conjunction which has the meaning of "is also called," "is another name for," "is equivalent to," "equals." By the use of this conjunction, "idest," the word "or" is released for use in expressing alternatives, and we may be sure of the meanings of phrases such as "Turkish idest Aleppo galls," "tannin idest gallotannic acid," "muriatic idest

hydrochloric acid," "hydrobromic or hydrochloric acid," "geraniol or citronellol."

In the German language the same ambiguity exists as in English. "Oder" and "beziehungsweise (bzw.)" both may be translated (a) as the alternative "or," sometimes better using "or else," (b) as the equivalent "or," "also called" (for which "idest" is suggested), and the modified "or rather," "or to be more exact." In addition, these words have sometimes (c) the related conjunctive significance "and also," "and furthermore," "— and — respectively," and (d) "as for example."

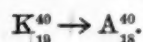
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SPECIAL ARTICLES

THE POTASSIUM-ARGON TRANSFORMATION

MØLLER and Weizsacker¹ have calculated recently the probability that a nucleus of atomic number Z disintegrates spontaneously through the absorption of a K electron from the extranuclear system of the atom into a new nucleus of atomic number $Z-1$ but with the same mass number. As Weizsacker points out, the possibility of such a process raises some interesting speculations concerning the relative abundance of the noble gases and their associated alkalis. Thus besides the usual beta emission from K^{40} , namely, $K^{40}_{19} \rightarrow Ca^{40}_{20} + \beta$, there might occur, if the masses involved in the reaction turn out to be appropriate, the reaction



When we consider that argon is in itself a very stable element, then this reaction appears more plausible. An examination of cloud chamber photographs taken with argon shows that A^{40} has a mean life higher than 10^{12} years.

An interesting feature of this reaction is the correlation of the most abundant argon isotope with radioactive potassium. If such a reaction is energetically possible, it implies the following. First, as Weizsacker mentions, argon should be found occluded in old potassium-bearing rocks; and, secondly, the ratio of the radioactive potassium isotope K^{40} to the others K^{39} and K^{41} should depend on the past history of the sample under consideration.

Weizsacker presents evidence which indicates that the rate of this reaction may be as high as $1/3$ the rate of the normal reaction, $K^{40} \rightarrow Ca^{40} + \beta$. A rate this high would require the estimates of the amount of

disintegration which has occurred in geologic time² to be revised upwards. However, it is unlikely that it is nearly as high as $1/3$. The ratio of the amount of argon in the earth's atmosphere and crust to the calcium content of the earth's crust is $1/100$. If we make the assumption that part of the argon generated in the earth's crust—assumed thickness of six miles—will have diffused into the atmosphere and that both of these elements have been formed exclusively from the disintegration of K^{40} , then the ratio of their rates of disintegration must lie in the range from $1/100$ to $1/700$. This appears to be a more reasonable value.

Møller has calculated the rate of the reaction resulting from the absorption of a K electron. With this knowledge, it is quite easy to calculate the rate of disintegration arising from the presence of free electrons in the material. If there is one free electron per atomic volume, then the ratio of free electrons to K electrons in the nucleus should be roughly proportional to the ratio of the volume enclosed by the K shell as compared to the atomic volume, *i.e.*, roughly as $1/Z^3$. On account of the dependence of the electron concentration on external conditions, the amount of K^{40} which has disintegrated during geologic time might well have varied by a quantity of the order of 0.01 per cent. from one locality to another on the earth's crust. If such a variation in the ratio of the potassium isotopes with environment could be detected, it would furnish strong evidence for the existence of the process.

Radioactive potassium K^{40} emits two groups of beta particles with v/c values of 0.93 and 0.83, respectively. In addition, homogeneous gamma of $2 \cdot 10^6$ e.v. energy rays have been detected. The relative proportions of these three processes are 40, 60 and 1.08, respec-

¹ Møller, *Phys. Rev.*, 51: 84, 1937; Weizsacker, *Phys. Zeits.*, 38: 623, 1937.

² Brewer, *SCIENCE*, 86: 198, 1937.

ively.³ Since the energy of the gamma rays is not equal to the energy difference of the two beta rays, it is probable that the radiation accompanies the absorption of the K electron to form A^{40} . The value of 1 per cent. for its occurrence fits in well with the value of 1/100 to 1/700 calculated from the abundance ratio as both may very well differ by a factor as large as 2 or 3 from their true values. Moreover, if these gamma rays accompanied either one or both of the beta groups, their frequency of occurrence should be equal to the frequency of the beta emission instead of 1/60 or 1/40 of that.

For the dual process, the energetics of the system practically requires that the process be accompanied by either gamma or neutrino radiation. Let E_A and E_p represent the energy of the ground state of the nucleus of A^{40} and K^{40} , respectively: if E_K is the energy of the K electron of mass m , then provided no radiation is emitted

$$E_p + E_K + m c^2 = E_A.$$

The chance that a level of the argon nucleus satisfies this requirement is vanishingly small. The most probable transition is

$$E_p + E_K + m c^2 = E'_A + \gamma$$

where E'_A represents an excited or ground state of the argon nucleus and γ the energy of the radiation emitted by the electron as it is absorbed into the nucleus. Knipp and Uhlenbeck⁴ have computed the probability of the production of gamma and neutrino radiation by an electron leaving the nucleus. The calculations for the dual process where the electron is absorbed by the nucleus is essentially the same. These considerations indicate that the dual process should be accompanied by radiation. The fact that the gamma radiation is homogeneous forces us to adopt one of the two following conclusions: (a) A single excited state E'_A exists 2×10^6 e.v. above the ground state E_A . The excited state E'_A lies slightly below the ground state of potassium E_p . However, if such a situation occurs among the nuclear energy levels, then it is hard to see why the alternative electron transition directly to a lower state does not take place. (b) If such a level E'_A does not exist, and the gamma radiation is emitted through the dual of the process investigated by Knipp and Uhlenbeck the energy dissipated per disintegration through neutrinos must be constant. This concept is in contradiction with the theory of beta ray emission.

The observations, presented above, concerning the ratio of the abundance of A^{40} and Ca^{40} on the earth's surface and the production of gamma rays accompany-

ing the disintegration of K^{40} constitute strong evidence for the occurrence of the dual process in the disintegration of K^{40} .

The author appreciates the opportunity of cooperating with the members of the Fertilizer Research Division of the Bureau of Chemistry and Soils, especially Dr. A. K. Brewer, in the solution of this problem.

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EXPERIMENTAL MODIFICATION OF THE SEXUAL CYCLE IN TROUT BY CONTROL OF LIGHT

THE work of Rowan,¹ Bissonnette,² Cole³ and others on the manipulation and control of the sexual cycle in birds is well known. Bissonnette⁴ further extended his work to include mammals. As far as is known the modification of the sexual cycle in fish by similar means has not received any attention.

Sheep, deer and some plants are known to become sexually active when the length of the daylight period is decreasing in duration. Brook trout *Salvelinus fontinalis* normally spawn in New Hampshire during October, November and December. A selected group of these fish were stripped on December 17, 1936, and then placed in aquaria where they were held for experimentation. A late spawning strain of fish was deliberately selected for study and experimentally exposed to an artificial light cycle which was designed to simulate the total number of hours of sunlight to which the fish were exposed during the average year at 44° latitude. Starting on February 20, 1937, the daily light period was increased gradually one hour per week until eight hours of light were added to the normal daylight period. The light hours were then gradually decreased until the normal day was reached. The accompanying figure graphically portrays the experiment. Calculations were based on U. S. Sunshine Tables⁵ for 44° latitude.

A 25-watt mazda lamp and a 16 cp. carbon filament lamp were suspended over each aquarium. The lights were automatically controlled by an electric time switch. After the added light reached eight hours the period of illumination was gradually (approximately one hour per week) reduced to the normal day, and then the experimental aquarium was covered in increasing amounts each week until the equivalent of an eight-hour day was produced. On August 12, 1937, all the experimental male fish were found to contain copious quantities of spermatozoa and could be

¹ Wm. Rowan, *Proc. Boston Soc. Nat. Hist.*, 38: 6, 147-189, 1926.

² T. H. Bissonnette, *Physiol. Zool.*, 5: 1, 1932.

³ L. J. Cole, *The Auk*, 50: 284, 1933.

⁴ T. H. Bissonnette, *Jour. Exp. Zool.*, 12: 4, 1935.

⁵ U. S. Dept. Agr. *Sunshine Tables*, Part II, W. B. No. 805, 1923.

³ Bocciasetti, *Atti. accad. Lincei*, 17: 830, 1933.

⁴ Knipp and Uhlenbeck, *Physica*, June, 1936.

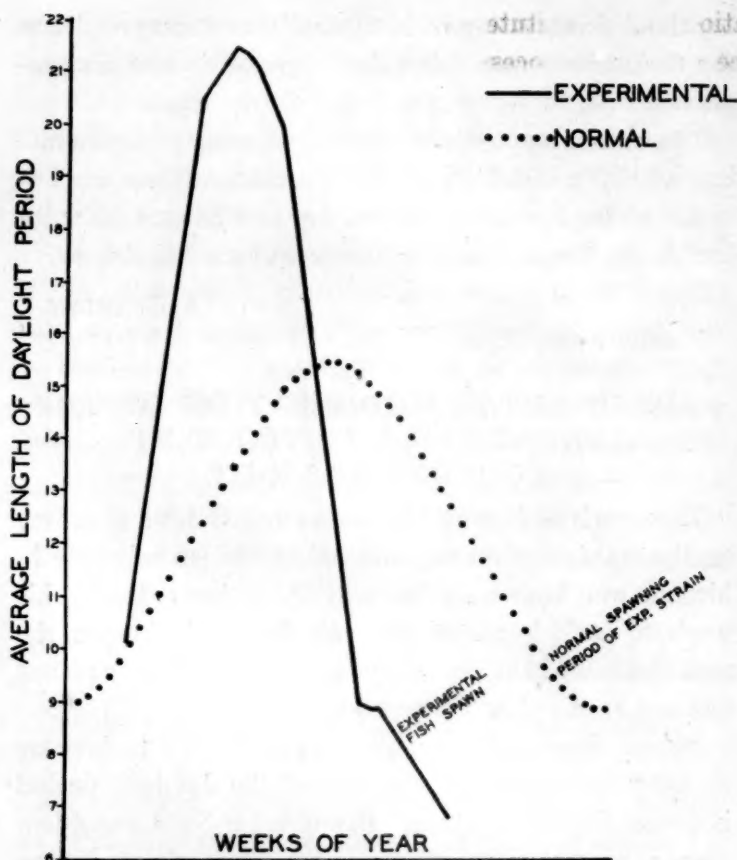


FIG. 1. Showing experimental treatment of the trout by modification of the diurnal light period.

stripped in the usual hatchery manner. The female fish were not quite ripe. Male fish in the wild commonly ripen as long as two or three weeks before the females. The first eggs were taken from the female fish on August 31, 1937, which is approximately three months before the usual spawning time of the particular strain of trout used in the experiment. Control fish which were kept under similar temperature, food and water conditions with the exception of light manipulation showed no evidence of sexual activity.

Similar experiments were carried out on rainbow trout which were induced to spawn in December, 1936, by gradually increasing the average length of day. Rainbows *Salmo irideus* normally spawn in March in New Hampshire, but the degree of hybridization with fall spawning strains was not known, so the data were not published at that time.

It is not known definitely from the completed experiments if it was necessary to add light to the brook trout to induce spawning or if merely diminishing the daylight period would have been sufficient. It is also possible that a combination of the two methods might be most efficient, but it is evident that the sexual cycle of fish, like those of mammals and birds, can be manipulated by controlling the length of day.

The practical value of inducing early spawning in rainbow trout by this method is evident in that most of the strains of these fish in New Hampshire do not spawn until spring and the fry are too small to plant with any degree of success in the streams by fall,

which necessitates the expense of carrying the fish through the winter.

The experiments will be fully reported elsewhere.
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DEPARTMENT
CONCORD

VARIATION OF DACTYLOMETRA QUINQUECIRRHA¹

IN order to attack the problem presented by the Scyphozoan medusa, *Dactylometra quinquecirrha*, L. Agassiz, in the many variations known to exist in its wide geographic range and especially in the Chesapeake Bay, where maturing in the "Chrysaora" stage, it occurs abundantly as two distinct varieties, life history studies of this common sea nettle have been in progress at the Chesapeake Biological Laboratory for three years. In the course of the studies, the organism has been reared, for the first time, through its entire life cycle from the egg, which was fertilized in the laboratory, to the resulting medusoid. The conditions under which this has been accomplished have been as simple and as nearly natural as possible.

The males and females may be easily distinguished when mature by the color of the gonads, which is greyish brown in the female and pink in the male. Fertilization has been determined to occur in late summer under both experimental and natural conditions. This takes place at night between seven and twelve o'clock under laboratory conditions. The process of cell division is rapid, and the following day free-swimming, pear-shaped planula have been developed.

At the end of the third day, the planula attaches itself firmly to the bottom. It is now ninepin-shaped. The tentacles are developed in a ring just below the mouth, and appear as simple outpushings of the body of the animal. After the formation of the first four tentacles, four invaginations are produced, which become the four taenoli or gastric septa of the scyphostoma. The tentacles increase in number until in approximately three weeks there are sixteen of them. Some few individuals may bear twenty tentacles.

The scyphostoma undergoes little change, other than that of size, from late fall until early the following summer. It is practically colorless, showing at times a faint pink, which becomes more intense at the time of strobilization, that is, in the early summer.

The process of strobilization in *Dactylometra quinquecirrha* differs from that of *Aurellia* and other similar forms for which knowledge is available, in that the number of discs produced appears to be fairly constant and does not exceed six. The ephyra produced as a result of this process have eight bifurcate arms, on every one of which there is a tentaculoyst.

¹ Preliminary note.

Upon growth, the Ephyra comes to resemble the adult medusa.

In the course of this study several interesting facts have been observed, two of which will be set forth. During the formation of the discs of the strobila, the unsegmented basal region of the scyphostoma forms a new set of sixteen tentacles. After strobilization has occurred, the small cruciform mouth of the basal region enlarges and the polyp regains its normal appearance and awaits the coming of the following summer when strobilization again occurs, followed by the reorganization of the Scyphostoma. Under controlled conditions, all the Scyphostoma do not undergo strobilization at the same time, thus prolonging the time of year during which this process occurs from early June until late July. Field observations disclose that medusae from post-ephyral to adult development may be found in a given locality from June until August, indicating that similar development occurs under natural conditions.

In July of this year (1937) ephyra were obtained

in large numbers near the bottom of deep creeks in the vicinity of Solomon's Island. On cloudy days and after heavy storms, the ephyra were found at the surface and well distributed from surface to bottom. At the same time they are not found in the near-by bay waters. The explanation of these results must await further investigation.

There is a strong indication that the results of this study may serve in the solution of the problem presented by the existence of two distinct varieties of the one species in the same locality. Since the study of the life history appears to be the logical approach to a fuller understanding of a little known form, it becomes obvious that such studies, supplemented by collected and preserved material, offer a solution for many of the taxonomic difficulties presented by the hydroid relationships and variability of medusae in general.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

CONCERNING THE HEMOLYTIC ZONE OF *H. PERTUSSIS* COLONIES ON COUGH PLATES

NEITHER Bordet and Gengou nor other European bacteriologists mention the zone which, under ideal conditions, surrounds single colonies of *H. pertussis* on cough plates. It is fleeting, not always visible—seldom present for more than a day or two. If, however, the positive culture showing the zone is kept in the refrigerator, it may be preserved for a week. In strong, reflected light, the zone appears distinctly darker than the rest of the surface, when the plate is held at an angle, and a good hand lens is used. If, as usually happens, the surrounding culture medium has already darkened (*i.e.*, the cherry-red color has disappeared), the zone is seldom visible.

The absence of this zone in freshly isolated cultures is probably due to extrinsic factors. For example, if the agar is too warm or the blood more than twenty-four hours old when it is added, if the surface of the cough plate is dry when it is exposed, if mouth saprophytes or air contaminants (especially mycoides) grow luxuriantly before *H. pertussis* colonies are plainly visible, the zone will not be present. In short, any external factor that makes the rest of the culture medium surface darker before the end of the third or fourth day of incubation will make this rather characteristic zone quite indistinguishable. Whenever the rest of the surface in the vicinity of the colony has lost its cherry-red color, the zone can not be seen.

If fresh, rather thinly poured petri dishes of freshly prepared Bordet-Gengou medium (with 20 per cent.

fresh, defibrinated human blood) are exposed as cough plates, and if other conditions are ideal, not only should the darkened zone be visible in reflected light on the third or fourth day, but when the positive plate is held against strong, transmitted light and viewed from behind (*i.e.*, the growth surface toward the light) no transition between the border of the colony and the zone is distinguished—the colony and the zone appear equally lighter than the rest of the medium—"hemolysis." The line of demarcation is where the outer border of the "hemolyzed" and unaltered medium meet. Other simple aids in the identification of *H. pertussis* on cough plates are:

(1) A pointed platinum wire, touched to the minute, glistening, smooth, markedly elevated, round, gray colony, on the third or fourth day of incubation removes most of the soft, slightly sticky growth.

(2) When touched with a minute platinum loop the colony never slides from its original position on the medium;

(3) A colony on the loop diffuses quite evenly in a droplet of water on a clean slide without much mixing;

(4) A clear (unstained) capsule is often seen in thin, gram-stained smears (counterstained with double-strength carbol-fuchsin);

(5) Cultures should give a positive Dold test before (and after) intensive vaccine cultivation.

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AN ECONOMICAL AIR COMPRESSOR¹

DOUBTLESS in many laboratories the need has been felt for a practical and economical type of air compressor, and perhaps the idea of converting a car motor into one has occurred to many. Such an apparatus has found sufficient application in our laboratory in operating the air turbine ultracentrifuge² to warrant a description of it here.

Briefly, the compressor consists of a second-hand model T Ford motor (other types of car motors would probably do equally well) in which the following modifications were made. In order to increase the compression ratio and thus increase the efficiency of the motor as an air compressor, it was necessary to partially fill the combustion chambers of the head with babbit metal. However, before doing this we inserted a completely threaded pipe six inches long into each of the spark plug holes so that when the head was assembled there would be a space of about one half inch between the level of the pipe and the level of the piston when the latter was in its uppermost position. A metal pin inserted through a small hole bored near the end of the pipe extending into each of the combustion chambers was found to aid considerably in anchoring the babbit metal in position.

The head was placed in a level position with the combustion chambers up. Melted babbit metal was then poured into each of the combustion chambers to the level of the end of the protruding pipe. This filled the combustion chambers of the head so that when it was assembled there was only about one-half inch space between the babbit on one side and the pistons on the other when the latter are in their uppermost position. (Perhaps a flat metal plate machined so that there is just sufficient space in the head to allow the air to enter and escape would be an improvement.) After the head is assembled four check valves with the gate valve opening upward were screwed on to the four short pipes extending out of the spark plug holes. (We used Jenkins one-half inch air check valves; ordinary water check valves are not satisfactory for this purpose.) It is desirable for greater efficiency of the compressor to place the check valves as close to the head as possible. The check valves are then connected by pipes to a storage tank tested to the maximum pressure desired.

The ends of the exhaust valves are cut off so that they do not contact the rotating cam shaft, thus permitting them to remain closed at all times. The ends of the intake valves are likewise cut off so that they,

too, do not contact the cam shaft. The intake valve springs are weakened by cutting off the ends until only a slight tension exists when the valves are completely closed. Thus, when the machine is operating the intake valves work automatically, opening on the downstroke and closing on the upstroke of the pistons.

The compressor was then mounted on a suitable frame and an eleven-inch pulley attached to the crankshaft. We have used a five horse power electric motor with a six-inch pulley to drive the compressor, but if such were not available a second-hand car motor would perhaps do equally well. Because of the heat generated by the compressing of the air, it is advisable to retain the original water cooling system of the motor or, perhaps more conveniently, to attach the circulatory system of the compressor to the water tap. Oil is placed in the crank case to the proper level.

With the air compressor just described we were able to obtain 100 pounds pressure in a 30 gallon tank within one minute and maintain a constant pressure of 80 to 90 pounds while operating the air turbine ultracentrifuge, which has an escape at this pressure of approximately 12 cubic feet of air per minute. More or less pressure may be obtained by increasing or decreasing the speed of the compressor.

A number of variations for this type of air compressor made out of a converted car motor are no doubt possible. In fact, it seems feasible that certain of the cylinders might be modified to compress air, while the remaining ones are used as the driving motor. However, we have not attempted to construct such an apparatus.

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¹ Aided by grant from the Rockefeller Foundation for research in cellular biology.

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